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British Foundrymen's Association (Sheffield Branch).—"Modern Foundry Equipment and Design," by H. S. Green.

NOTES AND COMMENTS.

Pattern Shop Economy.

In the race for business which is such a pronounced feature of modern industrial life, one is continually running across recipes for economically conducting works and factories; and it is interesting to note how different minds regard the possibility of cutting down expenses. To some the greater scope lies in the installation of plant of the very best and most modern description, and, like the late Sir Alfred Hickman, they will often scrap machinery which other men would patch up in order to save the outlay on new, and install expensive modern appliances. Others, again, will keep a machine running to the last moment and scrap it then with severe misgivings as to the possibility of getting just a little more out of it. While it is needless to say that not every works can stand the cost of throwing out machinery that gets somewhat out of date, in most cases it is really more expensive to keep an inefficient machine than to throw it away. But apart from the extremists just mentioned, there are those students of foundry economy who see a considerable room for improvement in the minor details of shop arrangement and management; and really, to the average founder, the economies that can be effected in this way are of considerable moment. Some interesting comments on this subject were given in a paper on "The Pattern Shop of To-day," read by J. L. Gobeille, before the Pittsburg (U.S.A.) Foundrymen's Association in February last.

Some American Suggestions.

The writer first relates how he substituted concrete patterns for a good many of the wooden ones formerly employed, and claims that great economies can be effected in this direction by using reinforced concrete. He finally offers the following suggestions:—

(1) Re-arrangement of tools. To-day in most pattern shops the tools are put in helter-skelter. A skilled workman will spend more time walking and carrying his timber than in the actual operations involved. Change the disposition of your tools so that the natural operations may be sequential. Nearest the timber racks place the cut-off saw, then the big jointer, and the surfacer planer; next the combination cross-cut and rip saw, band saw, jig saw, segment cutter and the big trimmer in the order named. Have also one of the new toy jointers conveniently near the bench of every man; they are twice as helpful as any trimmer.

(2) The second source of saving is in having a good foreman. A bright, ambitious young man just out of his time who has taken a course of mechanical drawing makes a splendid man for a foreman. Do not select one who knows too much about pattern-making or depend on him for carrying out intricate valves or cored work. He can hire men who know all about such details. A young man out of a good technical school makes a splendid foreman, and one who will get out work and keep accurate cost account of it.

(3) The third suggestion is a careful division of labour. If you run more than 25 men you will be

able to save more than 25 per cent. right at the start. Get a good turner and allow him to do nothing else. Get a good man on beds and housings, give him a gang of five men to help him and keep him at that and similar work all the time. The same with cylinders, small valves, parts, fittings, etc. Each man at what he can do best with cheap help will cut the average wage rate considerably.

The Value of the Trained Man.

In regard to the first suggestion, this stands on its own merits, for the value of the proper arrangement of tools is beyond dispute. But there will probably be many who disagree with the claim that the bright, ambitious young man makes a splendid foreman. Certainly the foreman of a pattern-making shop requires a very wide knowledge of foundry work in general—a knowledge that many a first-class bench hand does not possess—and this is where the value of technical training comes in. True also is it that a good foreman may be inferior to some of the men under him in actually carrying out special or intricate work. The fact is that the qualities that go to make a first-class pattern-maker do not necessarily fit him for the control of a pattern shop. He may be well worth a foreman's wage at his own particular work, but be all "at sea," in the handling of men and the arranging of work. Then again, there is that factor, so often ignored but so influential where the management of a number of men is concerned—the personal element. The tact, dignity and appreciation of human nature that is necessary for the control of one's fellow workers, particularly if they are men with years of experience behind them, is not possessed by everyone, and it is very easy for the bright young man on taking charge of a department to set the best workers "by the ears," to the detriment of the work and the general harmony of the whole concern. Since, also, a foreman is constantly being called upon to decide some important matter for those under him, he must be well read in every branch of the trade, and too often this knowledge is only gained by experience. While we do not set out necessarily to dispute the claims of the writer quoted above, the qualities of the experienced workman who has supplemented his experience by technical studies are well worth considering, for he is quite as likely to hold the respect of the shop as the young man. Too often, however, men with some few years of experience to their credit are very slow at assimilating new ideas or adapting themselves to new conditions, and this is where the young man, unhampered by precedent, that bug-bear of progress, usually excels. This failing of clever and experienced men is well summed up in a remark once made to us by an employer—"If only these elder men would remember that for every day they have lived the world has taken another turn, they would be worth twice as much to me."

Making Alloys in the Crucible.

Owing to the difficulty which many foundrymen experience in getting satisfactory results from certain non-ferrous alloys made in their own furnaces, it has become customary to rely on the smelting works to supply the primary alloys, such as manganese-copper, silicon-copper, phosphor-copper, etc., these being bought in the form of ingot and re-melted for the final mixture in the foundry. There are, however, many instances in which a foundryman is called upon to make a complex mixture and where it is not convenient to wait for the delivery of the alloy, or perhaps not desirable to employ the standard ingot metal supplied by the smelter. In such cases it is necessary to mix the metal in the crucible furnaces in the foundry, though great care is then essential if excessive loss of some of the metals is to be avoided and an alloy of definite constitution obtained. It is, however, the cheaper method from the point of view of actual cost to the founder, and some firms are now using crucible furnaces for this purpose with very successful results. As an instance, for the production of certain alloys the United States Alloys Company, Curtis Bay, Md., U.S.A., recently installed in its plant a pair of Steele-Harvey furnaces which are handled together to produce certain alloys. One of the furnaces is mounted above the other and the various components of the mixture charged into the separate crucibles. When the materials in both are melted the contents of the upper furnace are poured into the lower, the metal thoroughly mixed and then poured into ingots. This arrangement of the furnaces makes it possible to produce any mixture that could be made in pit furnaces, and to melt the different ingredients at their proper temperatures and mix them without loss or injury due to oxidation or other causes. The large size of the pots which can be handled in this way facilitates the production of a more homogeneous product.

Deoxidiser for the Steel Foundry.

In all processes for steel-making some of the metal becomes oxidised, and as the temperature of the molten mass approaches the point of solidification the carbon contained in the metal reacts on the oxide of iron, reducing it and forming carbon monoxide gas. This gas forms blow-holes in the casting, and as the reaction continues until complete solidification, or so long as there is any oxide of iron present in the molten metal, it is necessary to remove or neutralise this oxide by some agent which will form a solid rather than a gaseous product. The materials most commonly used are silicon, aluminium, and manganese. A new deoxidising agent, silicon-calcium, has recently been brought out. These elements are combined in such proportions that when they are both oxidised they form a very fluid slag. Both are very active reducing agents, and are therefore efficient in removing oxygen. The oxides of the two form a slag which melts at or below 1,100 to 1,200 degrees C. (2,012 to 2,200 degrees F.). The compound formed by these two oxides is commonly known as silicate of lime. Being very fluid at the temperature of its formation, it will rise readily to the surface of the bath and enter the slag. The silicon-calcium should be added in small pieces while teeming. Care should be taken to see that the silicon calcium is thoroughly immersed in the molten mass. It is said that the best results are obtained by adding it gradually as the ladle fills. For ordinary low-carbon steel the amount added varies from 0.1 to 0.2 per cent. For tyre steel containing 0.4 to 0.5 per cent. carbon as much as 0.25 per cent. of silicon-calcium may be used. For boiler plate steel, 0.05 per cent. has been found sufficient. It is claimed that calcium has a tendency first to unite with any sulphur present in the steel, removing it from the metal as calcium sulphide, which passes off in the fluid slag. After this, the remainder of the calcium, together with the silicon, unites with the oxygen. In this way the compound acts both as a deoxidiser and a desulphuriser. The material is made in the electric furnace, and the average composition is stated as follows:—Calcium, 25 to 30 per cent.; silicon, 65 to 70 per cent.; aluminium, 2 per cent. or less; and iron, 2 per cent. or less. This alloy is found useful in all classes of steel work, open-hearth, small converter or crucible metal.

Moulding Sands.

By J. Shaw.

A largely attended meeting of the Birmingham Branch of the British Foundrymen's Association took place at the Technical School, Birmingham, on Saturday, March 12, when a Paper was read by Mr. J. Shaw on "Moulding Sands." Mr. R. Buchanan presided, in the absence of the President, Mr. R. Mason.

The CHAIRMAN, introducing the lecturer, said the subject of moulding sands was one of great importance, from the foundryman's point of view, and he especially congratulated the trade and the Association on having secured a new member to read such a Paper. They very much needed new men with fresh ideas, and that Paper might well be an incentive to others to follow the example.

The Paper was as follows:—

When our Secretary asked me to read a Paper to you, it was with some misgiving I selected the present subject. What influenced me was the fact that I was investigating at the time to find some method to reduce the need for skin-drying certain of our work. At the same time, the subject is one on which most of those present have some opinion, and the discussion should be a profitable one to all. I do not propose to deal with any sand but that, suitable or otherwise, for green sand in moulding; to attempt to cover sands for loam, cores, steel, etc., would enlarge the scope beyond a night's discussion.

It will be well, first of all, to consider the ideal qualities of sand; it should be refractory, porous, strong, and of a correct-sized grain.

Refractoriness.—This quality is determined by the amount of free silica and the purity of the clay. The higher the percentage of free silica and the purer the clay, the higher the refractory power of the sand. Other things being equal, the larger the size of the grains of free silica, the greater the heat-resisting power. All other ingredients in sand, except free silica and pure clay, tend to reduce its refractory nature.

Porosity.—With porosity I have classed permeability; but, of course, there is a distinct difference. By porosity is meant the amount of pore space a sand contains in a given area; by permeability, the freedom with which a gas can travel through the same area of sand. Two sands may have equal pore space, and yet one may be less permeable than the other. The porosity of the sand determines the amount of venting necessary in a mould, and depends on the proportion of free silica to the clay, the size and shape of the free silica grains, and the condition of the clay. Generally speaking, the greater percentage of free silica, the greater the porosity of the sand, as the grains of this ingredient are comparatively large. The grains should be kept as large as is compatible with obtaining a fine skin on the casting. As free silica has no coherence, the percentage is limited by the clay needed to give the necessary bond.

According to the investigations of King, if the grains are angular and of approximately the same size, the pore space for any given size is increased, because angular particles will not pack so well. A sand containing comparatively fine grains of a uniform size will be more porous than a sand composed of coarse and fine particles.

Strength.—The strength of a sand depends, to a great extent, on the clay contents, but the purity of the clay, the shape of the free silica particles and good mixing are other factors. As already stated, the smaller the amount of clay, the more porous and refractory will the sand be. It therefore follows that, where possible, the quantity should be kept as low as the weight of the casting will allow. The purity of the clay is important, because it takes less to give the necessary bond, and the impurities are the ingredients that fuse easily and thereby reduce both refractoriness and porosity. (This point will be further dealt with under chemical analysis.) Sands with grains having rough angular shapes are stronger than those with smooth surfaces, because they interlock.

That good mixing, either by hand or machine, adds considerably to the strength of a sand, is well known. Outerbridge tested this by placing test bars of sand 6 in. × 1 in. × 1 in., made under uniform conditions of pressure and dampness, on a smooth metal plate with sharp square edges; and by gently pushing the bars over the edge of the plate until they broke, he obtained some idea of the strength by measuring the overhang. A sand mixed and tempered by hand with a spade gave an overhang of less than 2 in., but when riddled a dozen times the test bars overhung about 3 in. before they broke.

Size of Grain.—The correct size of grain has been dealt with to some extent under the previous headings. A sand should be as fine as possible, to give a good skin to the casting, but the finer the sand, the more easily is it fused. Equal size grains give a porous sand, and a correct proportion of large and small grains gives a strong sand.

We have now some idea of the qualities we need in the sand for our purpose. Is it possible to formulate a set of standards that any sand can be compared with? It was with this idea that I asked several members to send a sample of the sand they were using, and at the same time to answer a number of questions as to treatment, size and shape of castings made, etc. But I must confess that owing to the personal element, sand differing in many respects gave equally good results. When a moulder enters a shop, he after a time adapts himself to any new conditions, and by inquiry and practice overcomes difficulties in the sand which may vary in many respects from the one he has been used to.

The usual tests for sands are chemical analysis, sieve test, and microscopic examination.

With regard to chemical analysis, I should like to emphasise two points. Many people understand that when an analysis of sand is given showing, say, 80 per cent. of silica, free silica is meant, forgetting that a proportion is united with the alumina. It is for this reason I have used the term "free silica" previously. As already shown, this ingredient gives refractoriness, porosity, grain and low shrinkage to the sand, but has no bonding properties of its own.

In the same way a misunderstanding exists as regards alumina. To say a sand contains 9 per cent. alumina, does not mean it has 9 per cent. bond and the remaining 91 per cent. free silica, as clay, or hydrated silicate of alumina, to give it its chemical name, consists of 46.4 per cent. silica, 39.7 per cent. alumina, and 13.9 per cent. combined water, the latter giving the plastic properties to the clay. The bond of a moulding sand is pure clay, but it is generally mixed with impurities which weaken its bonding power.

Clay is formed by the decomposition of felspars. These are rocks containing silicate of alumina, together with silicates of the alkalies. After the rocks are decomposed, more or less of the alkalies are washed out by Nature's agencies, the amount remaining determining the purity of the clay and hence its value as a refractory and bonding medium. The purity of the clay determines the amount necessary to give a sand its correct bonding strength. From the above it is clear that the percentage of clay should not be figured from the percentage of alumina present, as all sands contain felspars, which in turn contain alumina. *This alumina in the felspar has absolutely no bonding power.*

As already stated, felspars are silicates of alumina, combined with silicates of the alkalies, and are present in all moulding sands. The amount should be as low as possible, as they tend to flux the sand under moderate temperatures.

Oxide of iron is present in all moulding sands, giving it its red or yellow colour. It may be united with the bond as an impurity, or it may form part of the free silica. In any case, it lowers the fusing point.

Lime is generally found in moulding sands; it makes the sand fusible, and the lower it is the better.

While it is generally conceded that chemical analysis of sand is of less importance than physical properties, much information may be gained if applied rightly. Its use at present is to check the impurities and to see that the sand is chemically up to sample.

Professor Ries points out there is no relation between the bonding power and plasticity, and the percentage of alumina present as is generally claimed. He gives the following analyses to show this, No. 1 being a coarse-grained, gravelly sand, and No. 2 a fairly plastic loam:—

	No. 1.	No. 2.	No. 3.	No. 4.
Silica	66.12	70.24	79.36	90.00
Alumina ...	16.54	16.62	9.36	4.50
Ferric oxide ...	4.46	3.94	3.18	1.44
Lime	0.40	0.08	0.44	0.10
Magnesia ...	0.22	0.09	0.27	0.10
Potash	2.67	1.41	2.19	Trace.
Soda	0.35	0.74	1.51	Trace.
Titanic oxide...	0.14	0.46	0.34	0.70
Water	4.90	4.16	2.02	3.04
Moisture ...	4.15	2.42	0.74	—

Other examples are given in Nos. 3 and 4; No. 3 is a well-known moulding sand for plate work, while No. 4 is a sandy brick clay of sufficient plasticity and cohesiveness to be used for brick manufacture. Judging from the analysis, it would be thought that No. 3 was more plastic because of its lower silica and higher alumina contents. The same author also states, that there is no relation between the chemical composition and the use to which the sand is put, and he gives a series of analyses, where sands totally different in composition are used for the same class of work (FOUNDRY TRADE JOURNAL, August, 1908).

Whether the method advocated by Field (to whom we are indebted for much information) will give a satisfactory solution, I have not had time to test thoroughly. Certainly it offers an explanation to analyses like those just mentioned. He suggests that what is known as "rational analysis" will give a more correct idea of the constituents of a moulding sand than does ultimate analysis. The former method separates the sand into three substances, viz., quartz substance, clay substance, and felspars, and he gives two examples of a sharp and strong moulding sand that lend point to his theory:—

Sharp moulding sand.

Ultimate analysis.			*Rational analysis.*	
SiO_2	80.66	...	Quartz substance	67.85
Al_2O_3	9.30	...	Clay, substance + iron oxide...	22.03
Fe_2O_3	4.53	...	Clay, substance less iron oxide	17.50
			Felspar	10.12

Strong Moulding Sand.

SiO_2	77.22	...	Quartz substance	51.66
Al_2O_3	9.26	...	Clay, substance + iron oxide ..	28.06
Fe_2O_3	5.56	...	Clay, substance less iron oxide	24.50
			Felspar	7.28

The same author gives what he considers the ultimate analysis of a good moulding sand should be.

	Per cent.
Total silica	75 to 85
Alumina	7 to 10
Lime below	2.0
Alkalies below	0.5
Iron oxide below	6.0

The total percentage of iron oxide, lime and alkalies, or the total fluxing agencies, should not exceed 7 per cent. In high-grade sand for heavy work they should not be more than 5 to 6 per cent. Mechanical analysis, or sieve testing, of sand is valuable because it gives an idea of the texture of the sand and indirectly of the permeability and refractoriness. Unfortunately, I found no two authors followed the same mode of procedure, and I think it would be a good opening for some member of our Association, who has time and appliances, to draw up a fixed routine so that results could be compared.

The first to deal with grain separation, that I found, was Morse, in the American "FOUNDRY," so far back as December, 1893. He simply divided his sample into coarse sand, fine sand, very fine sand, and clay.

Scott used sieves of 20, 40, 60, 80, and 100 mesh to separate his sand into different size grains. He took 10 grams of the dried sand, placed it with 10 steel balls 7-16 in. diameter, in the 100 mesh sieve and shook it with a circular motion for one minute. The sand passing through was weighed and credited to the 100 mesh sieve. The sand remaining on the sieve, together with the balls, was emptied on the 80 mesh sieve; the operation repeated, and so on, down to the 20 mesh sieve. Field's method is somewhat similar.

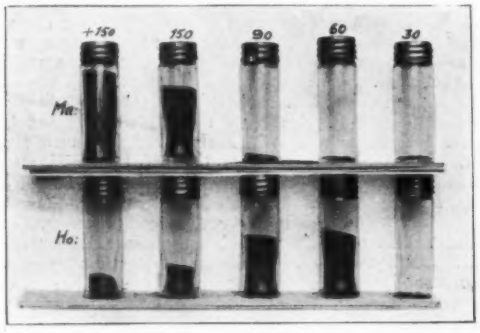
Professor Ries tackled the problem entirely differently. He took 50 grams of the sand and placed it in a 8 oz. bottle half filled with water. This mixture was put in a shaker for four hours, after which it was washed through a set of 20, 40, 60, 80, and 100 mesh sieves. The sand retained on each was dried and weighed. That which passed through the 100 mesh was caught in a jar. When all the water and suspended matter had been run through the sieves, the contents of the jar was stirred up, and after standing 45 seconds the water with suspended clay and fine silt were decanted off. More water was added, the contents of the jar again stirred, and the decantation repeated. In this way two sizes were obtained. That which remained in suspension he termed the clay, and that which settled was indicated as 100+, and most of it was retainable on a 150-mesh sieve.

Personally I tried both methods, but could not get even approximate results. With Scott's method, much depended on the condition of the dried sand, and more on the velocity and number of times the sieves were shaken. After making about 50 trials from the same kind of sand. I tried Professor Ries' wet method. This gave far better results, but with my limited time and lack of appliances took too long to get through the samples sent.

The method adopted at last was as follows:—Using 30, 60, 90 mesh sieves (because these sizes are English standards, and anyone can get a set for 3s. 6d.), I added a 150 mesh sieve so as to divide the finest portion. After rolling the dried sand under a light wooden ruler, to break up the compound grains, I weighed 25 grams, placing it with 10 steel balls 5-16 in. diameter on the 30 mesh sieve, and shook it

till practically no more would go through. The portion left was credited to the 30 mesh. Placing the balls, together with the sand which had passed through the sieves in the first operation, on the 60-mesh sieve, the same routine was followed, and so on till the sample was divided into five distinct sizes of grains, each portion being weighed and credited to the size of the sieve it rested on. That which passed through the 150 sieve was called 150+. After doing about 50 trials from the large sample the results were found as near as could be expected.

Coming now to the samples so kindly sent by various members, the chemical analyses of most were obtained. All submitted to the sieve test and microscopic examination.



MOULDING SANDS : MA = MANSFIELD FINE, HO = HORWICH.

To give a graphical idea of the differences in the samples, I obtained a number of screw-topped bottles, all about the same size. Taking five for each sample, the contents of each sieve was emptied into a bottle and the stopper marked with the mesh of the sieve and the locality of the sand. The five bottles were gummed on to a piece of cardboard, together with the answers to the questions sent. Starting in the North with samples from three prominent firms, all of whom use Erith sand; this is the finest grained sand sent in, and notwithstanding its high silica content, has a tendency to scab. I am indebted to Mr. Mayer for the following particulars: The sand is brought as ballast in boats on the return journey, and is sold in three grades. The weak top sand with least alumina, the medium quality with more alumina, and the strong, from the bottom of the pit, with most alumina, the last, of course, being used for dry sand and loam. The texture of this sand is so fine that it requires no mechanical treatment and is mixed with coal dust and in some cases a proportion of old sand, riddled and mixed ready for use.

The chemical analysis (kindly sent by Mr. D. Cochrane) was as follows, but, of course, the alumina content will vary according to grade.

SiO_2	88.25
AL_2O_3	7.70
FE_2O_3	2.50
CaO	0.72
MgO	0.58
Loss	1.00

Sieve Tests.

	Weak.		Medium.		Strong.
30	0.400	...	0.192	...	1.320
60	0.868	...	0.840	...	4.556
90	0.560	...	0.280	...	1.220
150	67.088	...	38.876	...	14.080
150+	30.468	...	58.088	...	76.020
	99.384		98.275		97.196

It will be noticed that the quantity in 150+ increases in bulk as the alumina increases.

From Lancashire three samples were also received, and curiously two of these were the coarsest grained in the sands examined; but that clean fine work can be made from them anyone who has seen castings at the Lancashire and Yorkshire Railway shops can testify. In both cases the sand is well milled to give it strength. The sieve test was: —

30	0.800
60	4'.140
90	39.056
150	13.020
150+	4.580
	98.596

The next section came from firms in the North Midlands, from pits at Worksop (2), Mansfield (3), Kirby-in-Ashfield (1). Mr. Pilkington gave the ultimate analysis and Mr. Houghton the rational analysis of their Worksop sand.

Ultimate Analysis.			Rational Analysis.			Sieve test.	
SiO_2	88.00	...	Quartz ...	66.25		30	0.008
AL_2O_3	7.20	...	Clay + FE_2O_3	12.00	...	60	1.280
FE_2O_3	1.20	...	Clay − FE_2O_3	10.80	...	90	29.308
CaO	0.20	...	Felspar ...	21.75	...	150	51.600
						150+	14.236
							99.432

The other sample from Worksop either was from another pit or a different strata, as the sieve test showed the sand to be considerably coarser, and it was used on heavier work without skin-drying. Mansfield also has two types of sand at least—a fine one for brass and light castings, and a coarser grained for heavier work. The analysis is as follows: —

Ultimate Analysis.		Sieve Test.		Fine.		Coarse.
SiO_2	84.26	30	...	0.388	...	0.156
AL_2O_3	6.70	60	...	0.928	...	2.632
FE_2O_3	3.50	90	...	3.388	...	15.128
CaO	0.19	150	...	39.160	...	60.932
MgO	0.68	150+	...	54.268	...	19.980
				98.132		98.828

The sample from Kirby-in-Ashfield was very similar in sieve test to Worksop.

From the South, Mr. Ellis sent me a sample of a local Southampton sand he uses. Not unlike Erith in colour (but darker), it is much coarser in grain, and castings up to 2 tons are made without skin-drying: the sand is not ground but mixed and riddled.

Sieve Test.

30	0.200
60	1.400
90	14.800
150	69.200
150+	13.320
	98.920

Taking our own district last, seven samples were sent in (including one from a firm at Cardiff, who obtained their sand from Stourbridge). The analyses and sieve tests are as follows: —

Ultimate analyses.

	Stourbridge.	Wordsley.	Kidderminster.	Tettenhall.	Whitwick.	Moxley (Med.)	Moxley (Loam).	Icknield.
SiO_2 ...	82.970	81.10	83.69	84.1	84.5	86.7	88.2	8 .6
AL_2O_3...	5.070	5.63	6.26	6.2	6.8	5.4	5.5	5.7
FE_2O_3...	4.960	6.20	4.10	—	—	—	—	—
CaO ..	0.550	0.70	0.66	—	—	—	—	—
MgO ...	1.170	1.01	0.51	9.7	8.7	7.9	6.3	8.7
K_2O ...	2.480	2.66	—	—	—	—	—	—
NA_2O ...	0.546	0.50	—	—	—	—	—	—
Loss ...	2.000	2.70	—	—	—	—	—	—

(Kidderminster, per Mr. P. Longmuir). (Last five analyses per Mr. J. R. Cooke, Wolverhampton).

Rational analyses.

	Stourbridge.	Wordsley.
Quartz substance	61.536	57.59
Clay ,, ...	11.210	14.46
Felspar	22.300	21.75

(Analyses by Mr. E. Taylor).

Sieve Test.

Stourbridge.		Wolverhampton.		Bl. M.		Kidderminster
30	0.496	... 0.548	...	0.400	...	0.08
60	6.416	... 1.328	...	7.992	...	1.608
90	17.820	... 13.500	...	23.548	...	16.992
150	49.896	... 47.696	...	46.348	...	55.84
150+	24.708	... 35.940	...	20.640	...	20.84

The sample from Wolverhampton was used on small work, and no doubt a coarser grade is sent out. Three firms simply add coal dust, cut, mix and put through a centrifugal mixer. Two grind in a mill. One both riddles and grinds and the last simply mixes, treads and riddles. The proportion of coal dust varies from 1 in 6 to 1 in 10. Old sand used varies from nil to 65 per cent.

Coming to microscopic examination, I found most of the grains of sand with worn edges, the Erith being the most angular. Geologists tell us the sand beds from which we in the Midlands get our material once formed the bottom of a huge lake, and was deposited layer upon layer, much as the bottom of Lake Geneva is being made to-day—hence the rounded appearance of the grains. The few slides exhibited will give a better idea of the shape, etc., than any description. The sand of each slide was taken from the 90 mesh sieve.

While no hard and fast rules can be laid down, a knowledge of the chemical and physical properties of your sand can but be helpful. That an artificial sand can be prepared, superior to any natural sand, and specially fitted for particular classes of work, I have proved, but the cost puts it out of the market.

In conclusion, I should like to thank the various friends who, at some trouble to themselves, have sent samples and information, and more especially Mr. Field, of Pittsburg, who, after I had failed from every source I had tried on this side, sent me his direct method for obtaining the rational analysis of sands, which I can but think will offer explanations for some seeming contradictions in chemical analysis.

A most useful addition to the paper was a large number of sand specimens in five separate grades of the grain, representing practically every description of sand used in the kingdom. The sands were placed in small phials, and were accompanied by descriptions and details of analysis from the senders or from experts acting in their behalf. An opportunity was given to members to inspect the specimens under a powerful illuminated microscope.

Discussion.

The discussion was opened by Mr. A. H. Hiorns, who said the lecturer had given them an admirable introduction to the discussion, and had embraced in his remarks the chief properties required in moulding sand for cast iron. While Mr. Shaw had confined himself to green-sand, the properties enumerated applied to sand for most castings. He thought it would be a pity for subsequent speakers to confine themselves exclusively to green-sand casting, as some of the members might be more conversant with other branches. There seemed to be a tendency to underrate the value of chemical analysis, because it did not explain everything. But they must remember that it only professed to reveal certain facts, and not the whole, so that too much stress should not be laid on the occurrence of different properties in sands of identical composition, because sand was not one uniform chemical compound, but a mixture of several substances which might, or might not, unite under the influence of heat, and so change the character and properties of the whole mass. Moreover, the texture or size and shape of grain largely determined the porosity, searching properties, and tendency to "scab," which could not be determined by chemical analysis. In that case, the microscope would afford valuable information. In fact, it was becoming more evident every day that the foundry chemist must also be an expert microscopist if he was to render the real aid the foundryman required.

Fortunately, continued the speaker, in the Birmingham district there were abundant supplies of moulding sand, both from lake deposits, as in the new red sandstone of Warwickshire and Worcestershire, and from the glacial deposits between Birmingham and Wolverhampton, known as the "boulder clays" and "gravels." Similar beds were found around Bilston, Moxley, and Wednesbury. But some works in other districts were not so fortunate. He noticed that according to Mr. Shaw's paper, Cardiff had to depend on Stourbridge for its sand, which must increase the expenses considerably. He felt sure that with scientific knowledge and careful investigation suitable sands might be found much nearer home, or could be made suitable by intelligent mixing. A very interesting point had been brought out in the paper, namely, that of sifting in altering the alumina content. That was a ready means of getting weak or strong sand from the same material. Another point was the tendency in Erith sand to scab, although the silica was high; but the rational analysis was not given, so that the condition of the silica was not shown. It was noticeable that that very fine sand required to be mixed with coal dust and old sand, and that it was angular in the individual particles, forming sharp sand. In the Lancashire samples the sand was coarse grained, and yet clean, fine work was obtained from it. But the nature of the facing was not given, and this might make all the difference. Probably silica, flour, or some other sand was used for facing, which would explain why such good castings were obtained. With regard to binding power, it might be taken for granted that the best moulding sand was that which contained just the right quantity of binding material, and although the cohesion of some sands might be improved by the addition of clay, it seemed to him that such a mixture was inferior to the natural product. It might, however, be made suitable by a thorough mixing. He fully endorsed Mr. Shaw's remarks, when he said that in this respect artificial sand was superior to any natural sand.

Mr. J. H. Stansbie said the lecturer had given them information about the porosity and permeability of moulding sands, and had emphasised the importance of those properties, defining porosity as the amount of pore space in a given area. Mr. Stansbie assumed that he meant by that the area of the walls of the mould. It would seem better to define it as pore space per unit volume, as it was through that space that the gases must leave the mould cavity. The permeability would then be measured by the rate of flow of gas through unit area, and this rate would be determined by the condition of the sand into which the gas had to pass. The porosity of any sand must be largely reduced by ramming, and a fine-grained sand, with much bonding material present, might be rendered practically impermeable by hard ramming, the spaces between the grains being obliterated by the interpenetration of the very finely divided bonding material. The rate of flow of gas through the sand was governed not only by the cross section of the pores, but also by the nature of their walls. The rougher the surface of the grains the greater the

frictional resistance to the passage of the gas, and the slower would be the rate of flow. From that it was evident that smooth rounded grains would give greater permeability than rough angular fragments, with the same pore surface. The importance of getting rid of the gas from the mould during casting was so evident that the investigation of a series of moulding sands would be incomplete without the determination of their relative permeabilities. With regard to the question of the loose manner in which the term alumina was applied in the statement of analyses, this could easily be remedied, as it was more than probable that the whole of the alkalies were present in the sand as undecomposed felspar. The potash and soda felspars were double silicates of those oxides and alumina, and since the ratio of alumina to potash was 1.09, and that of alumina to soda 1.64, the percentage of alumina present in those felspars was readily calculated. Thus, in No. 3, the sand used for plate moulding, the analysis of which was given by Professor Ries, there was 2.19 per cent. of potash, 1.54 per cent. of soda, and 9.36 per cent. of alumina. From those figures they had 2.9 by 1.09 plus 1.54 by 1.64, equalling 4.91 per cent. of alumina present as felspathic alumina. So that 9.36 minus 4.91, equalling 4.45 per cent., of alumina was present as clay bond. That clay contained practically 40 per cent. of alumina, so that 4.45 by $\frac{4}{1}$, equalled 11.12 per cent. of bonding material in the sand. If, then, the alumina and alkalies were given in the analyses of any sand, it would be easy to find the proportion of true bond present. With regard to the fluxing action of impurities, it might be remarked that the presence of ferric-oxide was not serious in the absence of reducing agents, but when coal was mixed with the sand or carbonaceous matter was used in the facing materials, reduction of ferric to ferrous oxide might take place, accompanied by considerable fluxing action. Lime was probably present in felspar, and exerted some fluxing action.

Mr. W. B. Parker said that the paper would be increased in value if they could have a set of references attached to it for the use of those who were not familiar with the literature of the subject. Personally, he knew some of them, though not all, and others were probably in the same position. The distinction between porosity and permeability was very ably put, but he did not think it was quite brought out that permeability really depended upon the uniformity of distribution of grain. Some of the drawings shown represented descriptions of sand through which the gases would pass freely, while others were much less permeable. But if those two different kinds were evenly mixed they would get even permeability, so that the latter quality was independent of the total pore space. That meant that sands should be ground and mixed very thoroughly to get evenness, and they had to consider also the question of the coal, coke, or other carbonaceous matter, which they had to deal with, because that would have a large influence on the porosity and permeability of mixtures, as well as on the strength of the sand. Another circumstance which affected permeability was the treatment of the stuff with water, which, being incompressible, must be forced out of the mixture in the form of gas, and that, therefore, added to the amount of gas which had to pass through the pore space; if those spaces were more or less waterlogged the pores would not act so efficiently as a means of letting through the escaping gases. Another mistake was for moulders to use the wet brush too frequently, as that added to the already excessive gases and, indirectly, reduced the sharpness of the edges of the casting. With regard to clay contents, the results given were purely derived results based on calculations from the ultimate analysis, so that really they did depend upon ultimate analysis.

Mr. Shaw explained that the results were obtained by the direct method.

Mr. Parker, continuing, said that the analysis was obtained upon the same principle as applied in the china trade, and they really did depend upon ultimate analysis in the final inferences to be drawn, while, with regard to clay, it was impossible to say what clay consisted of in its separate constituents. Although they knew its ultimate analysis they know very little about its actual condition, and the constituents in the clay. They knew that there was silicate, alumina, and so on, but that did not altogether determine its plasticity, or account for the plastic condition of the clay. That depended more largely upon its colloidal constituents, which determined what might be called its jelly condition. Ferric-oxide existed in that state, and all those substances found in clay also existed in the sand, and they probably existed in the colloidal condition. The plastic character of the sand mainly depended on that property.

Another important substance found in clays, and, therefore, in sands, was organic matter, although that was not even mentioned in the analysis, and whenever organic matter was found in sands it was probably derived from the clay constituents. Peat was a good example. It was generally found in clays in a colloidal condition. A good way of testing that was to take a piece of slate, which was really a hardened form of clay; on being examined by the microscope it was easy to see the grains of free silica, which were generally minerals, like pyrites and mica. Those were held together by substances which evidently consisted of this colloidal silica, and they could see the black patches of colloidal matter. Plasticity of clays did not depend upon alumina so much as upon its combination with other substances. It was clear that if they took an analysis of those substances they ought also to take the standard of pure sand. This contained 98 per cent. of silica, 2 per cent. of ferric oxide, and practically no alkalies whatsoever. Felspars were mentioned as being a source of very much of the material found in sand. Felspar was really derived from igneous blocks, such as granite, and that was why the materials were so closely mixed in the sand. If it were derived from felspar alone they would not expect to see free quartz. The proper way to continue that investigation was to combine the microscopic analysis with the ultimate and other rational methods. Mr. Hiorns had expressed his doubt whether artificial mixtures would equal natural products, but a good example was the material called gannister, nearly all of which was artificially made with the use of fireclay and other materials. Gannister was found to work very well for furnace linings and similar purposes, but the only natural gannister found was in the Sheffield district, and the sufficiency of the supply accounted for its use there.

Mr. Grant said that with regard to an enquiry for a definition of "scab," he took it to be that part of the mould blown back into the cavity of the mould by the pressure of the gases. He had never seen scabs produced by any other causes. It was usually caused by the sand being too close, and so preventing the gases getting freely away. It was often caused by the moulder packing the sand too closely. It appeared to him that a kind of sand known as "King freestone" was very suitable for dry-sand castings. It was possible to dry it as hard as stone.

Mr. Reason remarked that the majority of them were at a disadvantage, inasmuch as they bought their sand in small quantities, and could only judge it from

merely casually examining a handful without knowing its actual composition, and that gave a great deal of trouble. A foreman would get used to one kind of sand, and he would find another description furnished without any notice being given, and the first intimation was the trouble he found with the castings. He would like to know what was considered the best sand for thin castings. Some of the Scotchmen in the Glasgow district turned out wonderful work, and he would like to know whether the same result was possible of attainment in this locality.

The CHAIRMAN (Mr. Buchanan) said he believed the definition of "scab" given by Mr. Grant was perfectly correct. He understood it to be a portion of the walls of the mould being driven into the cavity by the pressure of the gases in the walls. That was why a man casting a heavy casting would always get his risers close, so as to get the internal pressure inside the mould; the internal pressure forced the gas out of the mould. The pressure should be greatest in the mould, and should be forcing the gas out of the mould and so tending to keep the walls in position. Probably the sand Mr. Grant referred to was what was called in the Glasgow district "rotten rock." It produced very sound work, and its only disadvantage was that they must not run the metal directly on the sand. In that respect, it compared badly with the Wolverhampton sand. With the local sand the metal could be run directly on the sand without the interposition of any coating of blacking or charcoal. In using the Glasgow "rotten rock," they coated it fairly heavily with a coating of charcoal, in such a way that the coating would not allow the metal to touch the sand. Otherwise, they would get fusion and rough castings. One of the advantages of Wolverhampton sand was that no such interposition was necessary, and so one moulding operation was saved. With regard to the casting of dies, there was a well-known firm in Shropshire that produced dies ready for work direct from the casting, and would make them up to one ton in weight. He had never seen them, but he thought he could postulate that by a coating of charcoal, or other carbon, on the face of those dies, they could obtain a suitable finish. With regard to the question of milling or hand mixing, which were very important matters, most practical men would agree it was not good practice to mill the sand if they were running very heavy castings, because the milling reduced the pore space. He certainly had a little difficulty in differentiating between porosity and permeability, but the milling of sand reduced the readiness with which gases could get away through the sand, and in heavy castings most practical men preferred to hand mix the sand, simply because they retained that permeability to a greater degree. There was a very material difference between milling sand in a dry condition and in a wet. Fine work, and the best results, he thought, were always got by milling sand dry, and then riddling it, so that the elementary grains were in an even condition. The riddling aggregated them and gave them grains in an even condition, and restored them to some degree of porosity, which was so desirable. He was for a time puzzled as to the reason why part of the surface of a thin casting was actually lower than the rim, as could be seen at once by putting a level across it. His explanation was that in working up the sand they had got it too finely grained and too close, and so there was a little layer of air or gas which could not get through the surface of the mould, and the casting was not heavy enough to force it away. It was not an uncommon trouble, and it was clearly best to allow the gas to escape. He thanked Mr. Stansbie for mentioning the difference between ferric and ferrous oxide. Silica would not readily combine with ferric oxide, but it would combine with ferrous oxide.

MR. SHAW, replying to a vote of thanks, which was heartily accorded on the proposition of Mr. Buchanan, said that with regard to the microscope, he could not say that he had personally found it of great value. All the sands he used were water-washed, and had all rounded edges and pretty much alike. If they were well up in mineralogy they might distinguish the different constituents through the microscope to some extent, but for ordinary use that was not of much value. With regard to rational analysis, it was exactly on the same lines as the ultimate analysis of iron, as compared with microscopic examination. Rational analysis would help them to some extent, and nearly enough for practical purposes, although it did not show the precise proportion of the constituents. As to artificial sand, he did not agree with Mr. Hiorns, who seemed rather to beg the question. It was rather obvious that if they got the precise materials and combined them, they had all that was most necessary. Some years ago he was in Germany, where practically all foundry sands were artificially mixed, and the Germans did very well indeed. To some extent, he agreed with Mr. Stansbie, and it was true that there was a distinct difference between porosity and permeability. The composition of certain of the sands would not account for the marked difference in their effect. In particular, they had practically the same alumina. If they only took account of the soda and potash, they would not get very safe tests. On the question of moisture, Germans mixed their sands dry, very much on the lines recently mentioned by Mr. Green in his paper, and they strictly limited their moisture to 6 per cent. Generally, he agreed with Mr. Parker's remarks on the subject of rational analysis, and it was true that there were effects not to be accounted for by composition. Dr. Mellor made practically the same observations some time ago in an interview he had with him. He had shared in some experiments for the renewal of material, the object being to enable them to use old sand instead of carting it away. They obtained a mixture which acted well for a time, but all at once it went wrong, and it appeared that really it became "dead," and they could do no good with it. With regard to iron oxides, they must not forget that sand was burnt a great deal, and so was turned into a ferrous condition. He had himself seen some very good work with "rotten rock" sand of the kind used in Glasgow.

BRITISH FOUNDRYMEN'S ASSOCIATION: BIRMINGHAM BRANCH.—There was a large attendance of the Birmingham Branch of the British Foundrymen's Association at the Technical School on Saturday, February 26, to hear a lecture by Mr. George Hailstone on "The Microscopic Analysis of Cast Iron." The lecture was illustrated by limelight views. Mr. Hailstone described the preparation of special sections by filing and polishing with various qualities of emery cloth, and other polishing substances, and he also exhibited views of various machines employed in the preparation of specimens. Powerfully magnified micrographs, some of them tinted by chemical treatment, were also thrown on the screen, and a number of microscopes were shown, including the one lately introduced by Mr. J. E. Stead, of Middlesbrough, fitted with a portable electric lamp, which apparatus was greatly admired. For the purpose of the lecture various apparatus was placed at the disposal of the lecturer by Mr. A. H. Hiorns, of the Technical School.

A Modern American Foundry.

In the accompanying illustrations is depicted the new Featherstone Foundry, Chicago, which was built for the production of miscellaneous locomotive and car castings, and which embodies the latest ideas in foundry construction and operation. The foundry trusses of the central bay, while the outer ends of the side bay roof trusses rest on the brick walls. All the outer walls are brick, with the exception of the south end of the foundry, which is made of cement plaster on expanded metal so that it can be readily

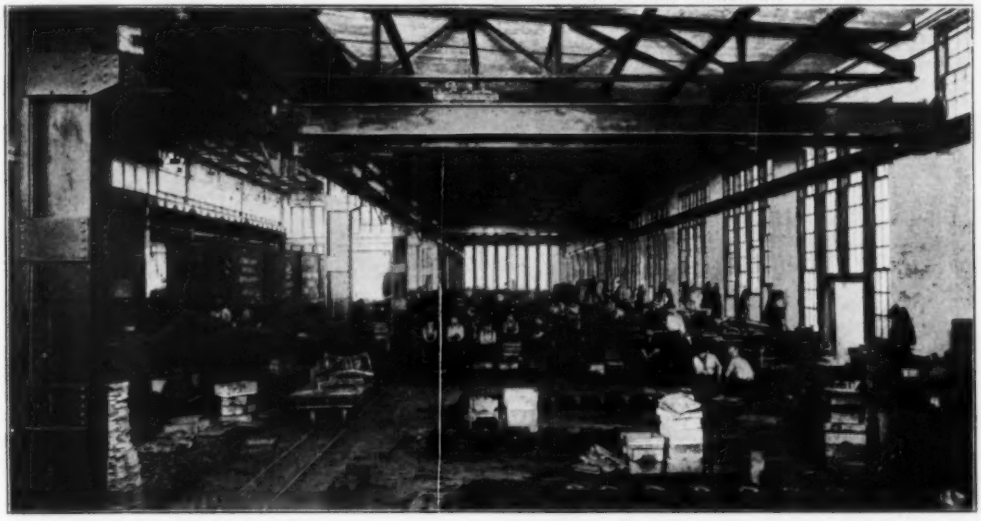


FIG. 1.—INTERIOR VIEW OF FEATHERSTONE FOUNDRY.

was placed in operation about the middle of last year, and has already worked up to an output of 75 tons per day. The moulding floor space is 3,200 sq. ft., and the production of castings is at the rate of 2 tons per sq. ft.

The plant consists of two principal structures, the foundry building and the pattern storage building. The yard is ample for the storage of material, the

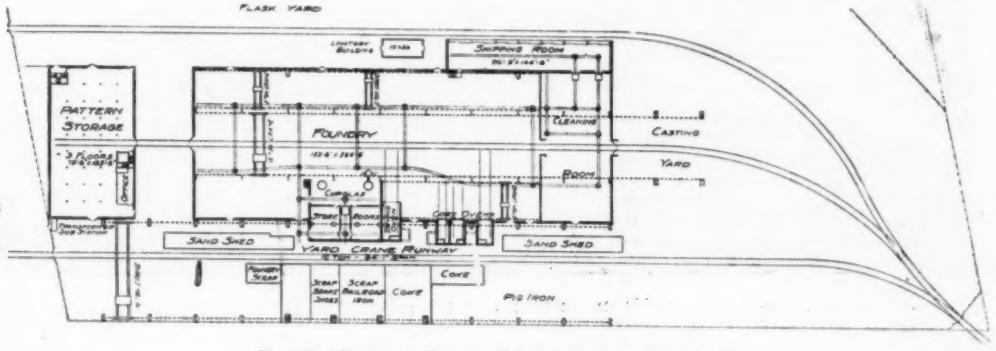


FIG. 2.—GROUND PLAN; FEATHERSTONE FOUNDRY.

storage bins, sand house, etc., all of which can be served by the yard crane, which runs practically the entire length of both buildings. The foundry building is 361 ft. long by 130 ft. wide inside, with side bays for shipping room, charging platform and ovens. Steel columns support the crane runways and roof

removed when any extension to the building is desired. The foundations are concrete, extending down to firm blue clay, and the wall footings are carried up with concrete to an elevation of 4 ft. above the clay floor. The roof construction is somewhat novel. Hyrib, an expanded metal manufactured by the Trussed Concrete Steel Company, was laid directly on and fastened to the steel purlins, which are spaced about 5 ft. span. On top of this expanded metal was spread $1\frac{3}{4}$ in. of concrete. Then the under side of the metal was plastered with cement, making the total thickness of the roof 2 in. Upon this was spread the regular 4-ply composition roofing. The central bay of the foundry is 59 ft.

wide and 31 ft. 6 in. high to the bottom of the roof truss. A standard gauge track runs the entire length of the building, and industrial tracks are conveniently located for handling ladles, castings, and other materials. A 15-ton electric travelling crane serves not only this entire bay, but the runways are extended out 80 ft. beyond the end wall, so that this crane can run over the cleaning room and outside for heavy cleaning and to serve cars. A passage is made

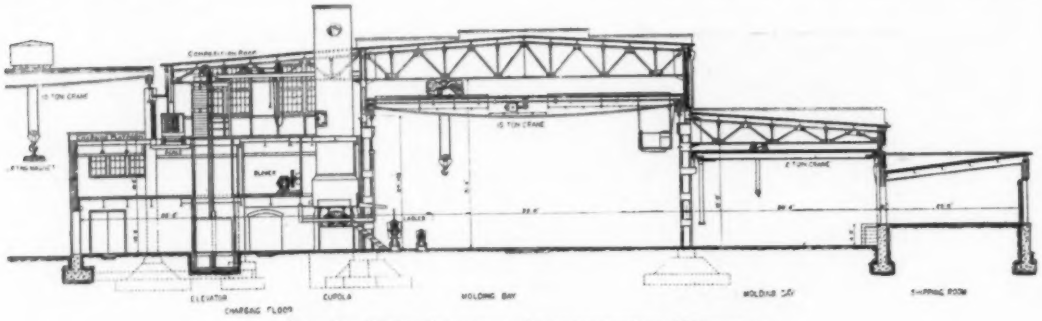


FIG. 3.—CROSS SECTION; FEATHERSTONE FOUNDRY.

in the end wall by means of five steel roller doors of the Kinnear type, which are operated by a 5-h.p. electric motor.

Special consideration was given to light and ventilation. The clearstorey windows are large size and alternate sashes are hung so as to slide to the back of the intermediate sash. These intermediate sashes are attached to an endless cable with chain inserts passing over the sprocket wheel and returning to a 4-in. compressed air cylinder. The windows are operated in four groups, each group provided with

the cupola and storage room is served by one 2-ton hand crane with electric hoist. The storage rooms extend 18 ft. outside the main building line and are each 29 ft. 5 in. by 25 ft. 5 in. by 10 ft. 6 in. high. Between these two storage rooms is an 8 ft. passage way leading from the elevator to the outside yard. At present only one cupola is installed, but provision is made for a second one. The one installed is a No. 9 standard Whiting, capable of melting 14 to 18 tons per hour. Immediately south of the storage room and cupola is the dry oven, 16 ft. by 35 ft. 9 in. and 11 ft. high inside. The core ovens, three in number, are 20 ft. long and of different widths, each provided with a steel roller door and trucks. Above the storage room is the mezzanine floor of reinforced concrete construction. Here are installed a No. 6½ blower supplying blast to the cupola and an air compressor with 8 in. by 12 in. cylinders, supplying air for the air lifts and for handling the upper deck sashes. On this floor is also provided ample room for

FIG. 4.—MATERIAL YARD, SHOWING CRANE; FEATHERSTONE FOUNDRY.

this device so that they can be opened or closed by means of a 3-way cock in an air pipe attached to a column on the main floor.

The east bay is 35 ft. 6 in. wide and 19 ft. high, and is served by two hand-operated 2-ton travelling cranes with electric hoist for use in moulding and pouring. The west bay is similar in dimensions to the east bay, excepting that that portion occupied by lavatories and lockers. Above the mezzanine floor is a charging floor. The portion of this floor inside the line of the main building wall is made of ½-in. steel plate on steel framing designed to carry a load of 500 lbs. per sq. ft., and it is surrounded by a steel curb 4 ft. high. The platform extending outside the main building is ½-in. plate, capable of carrying 800 lbs. per sq. ft. and has a steel plate curb 18 in. high.

The outside platform may be shut off from the inside charging room by roller doors hung between the columns along the wall line. The floor plates are all riveted to the floor beams and are made water tight. Just inside the door, and extending the width of the charging floor, is a transfer pit made of steel plates, and a truck running in this pit has a turntable and multiple beam foundry scale. The inside charging floor is also served by a 6,000-lb. electric freight elevator, and a hand-operated air hoist travelling crane is provided for handling coke. The outside charging platform is served by a 10-ton yard crane. This arrangement of weigh scales and transfer table is intended to save repeated handling. The lifting magnet on the yard crane will take scrap or pig-iron from the cars on whch it is shipped, raise it to the charging platform and deliver to the small cars. These cars then pass on to the transfer scale and are weighed and delivered to the cupola side ready for direct discharge into it. In the same way the coke is loaded into a square sheet iron bucket with drop bottom. This is delivered to the charging platform and set down on a frame with casters, and it can be moved over the transfer, weighed, and then on to the cupola, where it is dumped direct. This direct method of handling iron and coke to the cupola saves a large amount of labour as compared with the ordinary indirect method.

The cleaning room is 60 ft. wide, and extends across the south end of the building 130 ft. The partition wall between this room and the main bay is of cement plaster on expanded metal, extending in the side bays to the roof and in the centre bay only 16 ft. 6 in. high, to allow passage overhead for the travelling crane. Industrial tracks lead from the moulding room into the cleaning room alongside the tumblers and thence to the air lifts leading to the platform.

The pattern storage building is a 3-storey structure with reinforced concrete floors, columns and roof, and with brick exterior walls. The inside dimensions are 130 ft. by 72 ft. A 3,000-lb. electric elevator serves the three floors. The elevator shaft, together with the concrete stairway, is partitioned off from the main building by plastered tile partitions. The pattern shop is located at the east end of the first floor, and is supplied with a planer, band saws, and other pattern-shop equipment. These machines are driven by a 15-h.p. motor connected to a line shaft.

The yard crane is 84 ft. 1 in. centre to centre of rails, and extends along the west side of both the pattern storage building and the foundry, a length of 440 ft. The crane is equipped with a 10-ton electric trolley fitted with a lifting magnet having an ultimate lifting capacity of 3,000 lbs. The 15-ton travelling cranes in the foundry and the 10-ton yard crane are Shaw cranes, and the smaller hand cranes were made by the Maris Company, Philadelphia. The standard gauge track is located between the buildings and the bins, where cars are easily served by the yard crane. The lifting magnet is operated by a 10-kw. 220-volt direct-current generator connected to a 15-h.p. 3-phase 60-cycle 220-volt constant speed motor. This equipment is all on the bridge of the yard crane.

The motive power of the entire plant aggregates 475 h.p. and electric current is purchased from the Commonwealth Edison Company. Through six oil transformers the current is reduced from 2,200 volts to 230 volts 3-phase. The entire electric system is laid out with special provision for future extension and with special attention to safety devices so as to withstand the inattention or actual abuse which is almost sure to occur at times in a plant of this nature. All motors are 3-phase of the squirrel cage rotor type provided with 3-pole single throw oil circuit breakers with no voltage release, Westinghouse type H.

The lighting system of the plant is a 3-wire single phase alternating current system. A main panel is installed at the foundry building from which three main wires lead to the various distributing panels in the two buildings. The wiring is all done in conduits incorporated in the concrete floors and roof. The pattern shop is lighted entirely by incandescent lamps suspended from the ceiling by packing house cord. The lighting of the foundry is for the most part by means of type F automatic Cooper-Hewlitt lamps suspended from the steel purlins. The mezzanine floor and storage rooms are lighted with incandescent lamps, and Westinghouse receptacle plugs with 35 ft. extension cords are conveniently located for use in the cupola and dry oven. (The foregoing particulars are published in "The Railway Gazette.")

Mould Boxes in the Foundry.*

The earlier wooden mould boxes have been almost entirely superseded in the foundry, except for the purpose of casting firebars, their place being taken by cast-iron boxes, and to a smaller extent by wrought-iron boxes.

Cast-iron boxes are used almost exclusively for moulding machines, and their mechanical treatment depends on the construction of these machines. In order to turn out these boxes on a large scale, clean cast-iron patterns are essential. One of the simplest forms is shown in Fig. 1, the box resting on raised surfaces *a* at the corners, these surfaces projecting about ¼ of an inch and being planed true, thus saving the work of planing the whole surface. Filing is undesirable, the results being less accurate than those obtained with the plane. On the other hand, where the boxes are only used at intervals, these surfaces are liable to become uneven through rust, and need re-trueing, and in such cases it is preferable to do away with the projecting surfaces *a* and plane the entire under surface.

For accurate boring, a boring template is essential. For this purpose the author prefers heavy cast-iron templets, Fig. 2, which are more convenient for the driller. The projections on the outer surface of the templet, for the reception of the steel bushes, should be planed true first, and then the inner side, so that when the templet is in position on the box, only planed surfaces are in contact. The hard steel bushes, 2 inches long, in the bored holes of the templet, afford the requisite guidance to the spiral drill. The pattern plate on the moulding machine is provided with two pins on each side, instead of the usual two pins on one side and two holes on the other. This does away with

* O. Hutmacher, "Stahl und Eisen."

the expensive box pins for one half of the mould box. The top and bottom boxes are held together by means of two pins, Fig. 3, these being taken out as soon as the box has been locked.

In fitting up a new moulding machine shop it is advisable to have the bores of all mould boxes of the same size, so that the pins are interchangeable; and

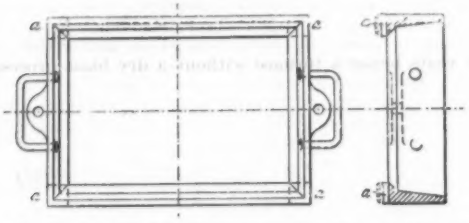


FIG. 1.—CAST IRON PATTERN FOR MOULD BOXES.

when the holes get worn—which will take a long time if the boxes be carefully handled—slightly wider steel bushes can be inserted in the templets, and all the holes reamed out to the new size. This will save lining the holes with hard lead or the like.

When the moulding-machine boxes are subjected to pressure on both sides, they are supported by an abutment that is loosely mounted on rollers. In order to

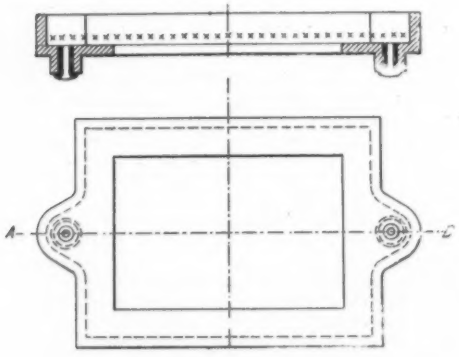


FIG. 2.—BORING TEMPLET.

prevent the unequal pressure arising from the collection of sand between the top box and the abutment, it is advisable to chamfer the upper side of the box to a cutting edge, as indicated in Fig. 4.

Wrought-iron boxes, though undoubtedly useful for moulding by hand, are not for machine moulding. Although the moulders are forbidden to work the machine boxes with the hammer, they will do so as soon as the foreman's back is turned; and a single blow with the hammer will often spoil a wrought-iron box for use with the machine. On the other hand, wrought boxes do very well for small steel and brass castings, and they are particularly suitable for steel-works use, owing to the numerous shocks to which they are exposed.

The practice of casting wrought-iron handles in with large cast-iron moulds, or even casting these moulds

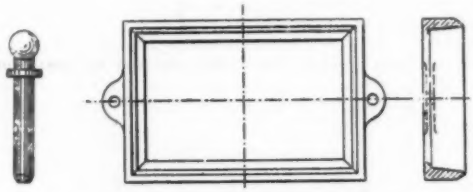


FIG. 3.—PIN. FIG. 4.—SHOWING CHAMFERED UPPER SIDE OF BOX

with handles at all, is inadvisable, the better plan being to provide the wrought-iron handles with collars and threads, so that they can be attached to the boxes by means of nuts and easily replaced when necessary. This also applies to the trunnions for large boxes, the thicker metal of the box at the point of attachment preventing them from breaking loose.

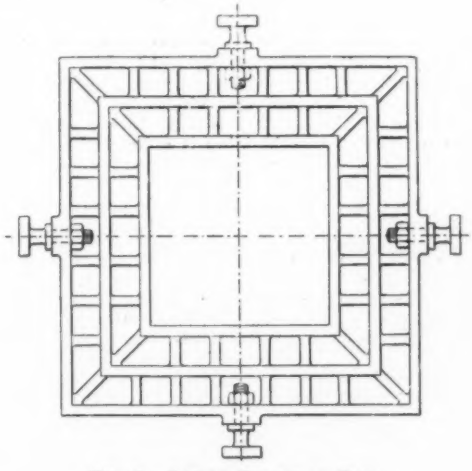


FIG. 5.—LARGE CELLULAR BOX.

In making large cellular boxes, Fig. 5, the central portion should be left as free as possible, the insertion of a few traverses being all that is necessary to fit the box for use in any particular case. The cells should be strong enough to allow heavy cores to be drawn without injury to the box.

BIRMINGHAM FOUNDRYMEN'S VISIT TO THE FIRE STATION.—The visit by the Birmingham Branch of the British Foundrymen's Association on Saturday, March 5, to the Central Station of the Birmingham Fire Brigade proved a most enjoyable and interesting event. A large party of members were received by Mr. Tozer, Second in Command over the Brigade. The visitors inspected the fire engines, escape, men's quarters, library, and recreation rooms. Afterwards, the Brigade gave a special display, showing considerable smartness in managing the engine and bringing out the appliances. A vote of thanks to officers and men was proposed by Mr. F. J. Cook (President of the National Association), seconded by Mr. Reason, and carried with acclamation; suitable acknowledgment being made by one of the Brigade officers.

Foundry Practice.

Cleveland Institute of Engineers.

At a meeting of the Cleveland Institution of Engineers, held at Middlesbrough on Monday, March 7, Mr. Greville Jones (President) in the chair, Mr. Edwin Lansdale, of the Ormesby Foundry, Middlesbrough, read a Paper dealing with the melting of cast iron and the influence of design and method of moulding on its physical properties. The following is an abstract:—

The first operation in a foundry—melting iron—requires a cupola, supply of air, fuel and flux, and pig-iron. Cupolas are of many types. The cupola should be of ample height to allow the stock to absorb as much heat as possible from the escaping gases, and not too large in diameter to allow of a medium pressure of blast to be used. A high stack induces a draft, therefore decreasing the resistance to the fan or blower, also carrying the flame and sparks to a safe height when blowing down. The coke should be of good hard quality, low in sulphur and moisture, and should be kept under cover, as it may absorb 15 to 20 per cent. of water. As the whole of the moisture has to be driven off, a certain amount of coke is consumed without doing useful work. The amount of coke used varies with the class of casting. If thin the iron would have to be very hot; if thick a duller iron is required. The quantity also varies according to whether the cupola is worked continuously or intermittently, and may run from 1¾ to 2½ cwts. per ton. The limestone is used in its raw state, being broken up into pieces about the size of an egg, and well distributed in the charge. The average quantity required is about 2 qrs. 14 lbs. per ton of pig used.

Fan Blast.

With regard to the air supply or blast, if supplied at too low a pressure the whole of the fuel may be completely consumed without doing useful work owing to the combustion being effected at too slow a rate to create the necessarily high temperature required to melt the iron, while if the pressure is too high there is a great waste of power. The pressure of the blast will vary with the size of the cupola, also with the rate of melting, and must be sufficiently high to penetrate to the centre of the cupola. A cupola 6 ft. diameter can be worked with 16 ozs. pressure, and one of 3 ft. with 8 ozs. pressure. The rate of melting can be increased by raising the blast up to 18 ozs. pressure, no further increase in the rate of melting being obtained with 22 ozs. pressure, and with 26 ozs. the melting would be slower. The best pressure is about 14 ozs., and where the rate of melting is not of importance, 6 to 8 ozs. may give the most economical results, but the author's opinion is that about 10 ozs. is the best pressure. The volume of air required in a cupola is usually expressed in cubic feet per minute per ton of iron melted per hour. For cupolas melting up to 10 tons per hour 500 cubic feet per minute, or 30,000 cubic feet per ton melted, will be required; for those melting over 10 tons 600 cubic feet per minute, or 36,000 cubic feet per ton, should be allowed for.

With regard to moisture, the author states that in a Paper read by Mr. B. Walter before the American Society of Refrigerating Engineers, relating to dry blast, it was affirmed that in America the quantity of moisture on an extremely cold winter's day was half a grain per cubic foot of air, and on a midsummer day 9½ grains, a ratio of 19 to 1, the variation in twenty-four hours frequently changing 3 to 4 grains. After describing the advantages of using dry blast at blast furnaces, he says there is no doubt that a few years hence a furnace without a dry blast process will be considered a back number. The extremes of climate are greater in America than in England, consequently they are troubled with a greater range of moisture. Mr. Charles Cochrane, from observations extending over twelve months, found the average moisture in this country to be 3.655 grains per cubic foot of air, being thus about equal to the variation sometimes experienced in America in twenty-four hours. Mr. Lansdale says he is of opinion that the application of the dry blast process to cupolas in England would not be a paying business.

The supply of the blast is practically limited to a fan or a rotary blower, preferably the first-named for a low pressure and the latter for a high pressure. The fan blower up to 8 ozs. pressure cannot be excelled for convenience and efficiency. From 8 ozs. to 16 ozs. the field is fairly divided between the fan and the rotary types. The advantage gradually shifts from the former to the latter as the pressure increases. Above 16 ozs. the superiority of the rotary type is manifest until in turn it encroaches upon the field of the blowing engine at about 5 lbs. pressure.

Fan Design.

Great strides have been made in recent years in the designs of fan blowers; the high speed at which they have to run makes them suitable for direct driving by electric motor, dispensing with shafting and gearing necessary when driving by the steam engine. The turbine has now entered the field in competition with the fan and rotary blower, and good results have been obtained with the steam-driven turbine blower at blast furnaces.

One of the main features of the fan is that the power consumed when delivering air varies with the work done and automatically adapts itself to the volume and pressure required. The rotary blower also automatically controls the pressure up to that fixed by the relief valve. Above that pressure the air escapes into the atmosphere, and power is wasted.

From a mechanical point of view the direct electrically-driven fan blower with flexible coupling is practically a perfect machine. The loss in friction is very small, the armature, arms, and cups being perfectly balanced and each rotating in space only, the shaft is in contact with another metal in the bearings.

In a fan blower the relations are about as follow:—The volume varies directly as the revolutions; the pressure varies directly as the square of the revolutions; and the power absorbed varies directly as the cube of the revolutions. The blast mains should be of large diameter to keep the velocity low, also as short as possible with changes of direction of large radius.

Cupola Charging.

The author then deals with the charging of the cupola, and states that to obtain the best results the average height of the melting zone is 15 in. above the top of the tuyeres. When the blast enters the cupola through the tuyeres a very considerable degree of expansion and consequent absorption of heat is

experienced; cooling takes places in the neighbourhood of the tuyeres, this being the reverse action to that in the blast furnace, where hot blast at a temperature of 1,400 to 1,500 degrees Fahr. is used. Many attempts have been made at foundries to follow the example of the blast furnaces and utilising the waste heat from the cupola for heating the blast, but without success. Mr. Lansdale's idea of utilising the heat is to make the cupola high, and thus to keep the stock as long as possible in contact with the heat passing off. The cold blast entering the cupola meets the liquid slag and iron passing in front of the tuyeres from the melting zone to the well part, and it becomes cool and frequently causes trouble. With hot blast these troubles would cease, but would the temperature created be too high for foundry purposes? The answer to that the author said he would leave to more practical men than himself.

Casting and Cooling.

Mr. Lansdale then deals with the cleaning of the tuyeres, with the leakage of the blast, etc., and afterwards considers at length the process of casting and the changes that take place during the process of cooling. The decrease in bulk due to contraction can be taken at an average of $\frac{1}{8}$ in. per foot, varying with the quality of the iron used, a hard or close-grained contracting more than a soft or open-grained iron. When designing heavy castings the effect of shrinkage must be borne in mind, so that one section is not fed from another, or shrink holes will be formed often rendering the casting useless for the purpose for which it is designed. Cast iron in its molten state consists of a saturated solution of carbon and iron, or practically all the carbon in a combined state. The more rapidly it is cooled the nearer the carbon remains in this state. With slower rate of cooling the carbon will separate from the iron, and be in the form of graphite or free carbon; therefore iron that is rapidly cooled becomes hard and close-grained and low in graphite; slowly cooled it will be soft and open-grained and high in graphite. This change is also partly influenced by the chemical properties in the iron. Iron in passing from the fluid to the solid state takes the form of crystals, these ranging in size with the grade of iron used and the rate of cooling. The crystals arrange themselves in a definite position, namely, at right angles to the surface in flat surfaces, and radially in curved surfaces; they arrange themselves along the lines the waves of heat travel in passing outward from the casting as it cools off. This property has a great influence upon the strength of the casting. It is practically out of the control of the moulder, and must be carefully considered by the designer to give best results.

Cast iron has a tensile strength of 8 tons and a crushing or compressure strength of 40 tons per square inch. If the various parts of the castings be proportioned to resist the intensity and kind of stress, on a theoretical basis there would be large pieces adjoining small pieces, and thin pieces adjoining thick pieces due to the high ratio of 5 to 1 of the crushing and tensile strength. Their rate of cooling will set up internal stresses causing one part of the casting to pull off from another part—rendering the casting useless for the purpose for which it was designed. The moulder exposes the thickest parts of the casting, leaving the thinnest parts covered, so that their rates of cooling will be as near as possible equal, thus reducing to a minimum the internal stresses due to unequal contraction. The author gives examples where the arrangement of crystals and variation in thickness must be considered, such as socket and spigot joints for cast-iron water pipes, flange joints for a steam or water main.

Discussion.

In the discussion the President read a communication from Mr. Ebenezer Adamson, of Sheffield, and late of Seaton Carew, respecting the keeping of coke dry. Some experiments with German coke were carried out on the Continent, The coke was allowed to lie on the charging platform under cover for about two months, when it contained 1.5 per cent. moisture. This was used for a week in two cupolas, and the coke consumption was 12 per cent., giving fairly hot iron. Similar coke was then immersed in water, and contained 9 per cent. moisture. It was used in the same cupolas for one week. The result was that both furnaces delivered strongly overheated iron, and the coke charge could have been reduced. The conclusion arrived at was that the coke could be allowed to stop in the open without hesitation, and that wet coke was superior to dry for use in the cupola. The reason assigned for this was that dry coke was more easily crushed than wet, whilst the latter remained in its normal condition until consumption. It was stated that all classes of iron increased in bulk when in their molten state, but that would depend upon the carbon in the solid metal, as there would not be the same ratio between molten metal which became white on cooling, and that which produced No. 1, which was quite possible. There was a great difference in the specific gravity of a No. 1 iron and a white.

Mr. T. D. Wilson, of Wilson, Copley & Company, Middlesbrough, who stated that he had been for fifty-five years engaged in the foundry trade of the Middlesbrough district, said the coke was the resistant power in a cupola charge, and if a strong, hard coke were used the best results were secured. His experience was that from 9 to 11 ozs. was the best pressure for the blast.

Mr. Henry Goldsborough, of Messrs. Bolckow, Vaughan & Company's Works, Middlesbrough, said that at their works they had introduced turbine blowers. Their foundry was altogether electrically driven, and it was astonishing how small an amount of power it took to run a foundry.

Mr. F. H. Marshall, Tees Ironworks, Middlesbrough, pointed out that with respect to the application of the hot blast for cupolas, the same economy would probably not result as that which was reported in connection with the blast furnace. The quantity of blast required per ton of pig-iron melted in the foundry was not so great as in the blast furnace. It would introduce complications.

Mr. Greville Jones, the President, remarked, with reference to coke absorbing 15 to 20 per cent. of water, he rather doubted it. His experience was with hard coke, but he did not see how a good, sound foundry coke could absorb. Even ordinary by-product coke gave better results, and it was not accounted so good as the beehive coke.

A vote of thanks was passed to Mr. Lansdale.

The fortieth annual meeting of the North Staffordshire Coal and Ironstone Workers Permanent Relief Society was held at Stoke-on-Trent on Monday, when Mr. E. Martin, f Halke, occupied the chair. The annual report stated that on December 31st, 1908, the membership stood at 5,039. At the end of the past year it was 4,784, or a decrease of 255. At the end of the year the capital of the Benefit Account stood at £25,596 4s. 10d., showing a decrease of £16 14s. 3½d., as compared with the previous year. On the same date the capital of the Management Fund stood at £973 6s. 11d., being a decrease during the year of £7 14s. 3d. The report and accounts were adopted, and the Duke of Sutherland was re-elected president.

Runners, Gates, and Dirty Castings.

By F. A.

The provision of gates in moulds is a subject worthy of more consideration than it generally receives. Improper gating may have several bad effects, such as the production of spongy places, cracks, blisters, unsightly scabs, and above all, dirty

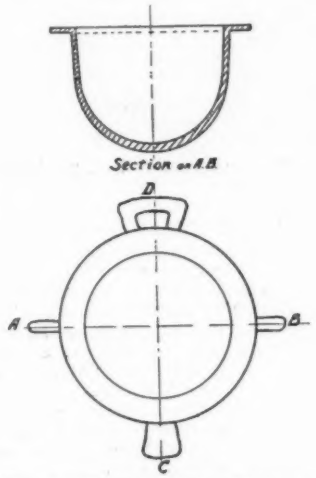


FIG. 1.—GATING A PAN CASTING.

castings. An unwisely placed gate may result in a faint-run casting, whereas, were the metal properly distributed by the same size of gate, such an occurrence would be avoided. A large gate playing on one portion of the mould will not only tend to produce a scab, but also to strain the mould, so that the casting when knocked out of the sand will show in places a number of projections or swellings, especially if the ramming has not been uniformly

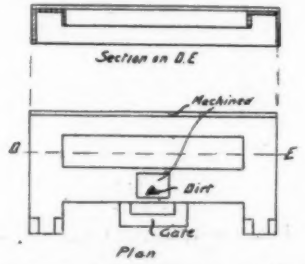


FIG. 2.—DIRT ACCUMULATION AT GATE OF CASTING.

done. Double the diameter of a round down gate or runner gives four times the area; that is to say, a round gate 2 in. diameter has a capacity for delivering metal equal to four round gates each 1 in. in diameter. Ignorance of this fact is the cause of much trouble; for instance, a moulder may alter his gating arrangement for a particular job, and replace a single gate by two others half the diameter of the original, with the result that the mould does not fill quick enough, giving a casting with round edges instead of square ones. The opposite to this occurs when the moulder, instead of having two small gates direct on top of casting, employs one large gate, and as a result gets a badly strained casting, unless other precautions are taken. An instance which came under the notice of the writer is illustrated in Fig. 1. This pan was cast right way up and had a good thickness at the bottom. It was necessary that it should not have the least scab on the inside, but when gated

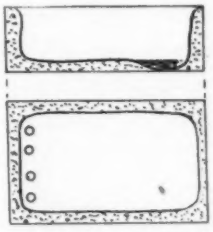


FIG. 3.—CORRECT RUNNER BASIN.

as shown at C, on one side of the flange, scabs could not be avoided. By gating as shown at D, with two sprays, and at both sides of the flange, the difficulty was overcome, and rarely occurred. From this example it was evident that the mould near the gate might stand 1 cwt. without scabbing, but if the whole 2 cwt. were to play on that part, the power of the sand would be overtaxed.

Some castings are dirty not so much through any fault in the moulding as to the unsuitability of the iron used. It is often noticed with some irons that a scum continually rises, and if this scum is taken off in the shank or ladle more scum takes its place,

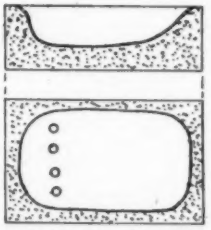


FIG. 4.—INCORRECT RUNNER BASIN.

the same occurring repeatedly until the iron solidifies. It is evident, then, that a casting of great bulk if poured with this iron would accumulate a large amount of dirt before the act of casting was completed, and this would be independent of any special form of skimming gate employed. If the casting is run from the bottom it is possible that near the top the sides of the casting will also be dirty, as the new metal coming into the mould will take a central course where there is least resistance by friction, and being the hotter and lighter metal will rise to the top through the centre, the scum already there being sent to the outer portions of the mould, which will have a tendency to hold it.

This will result in the filling of any side brackets or bosses with the dirty top metal. Such dirt may be due to oxidation of the silicon or manganese, to kish, or also to dirty scrap, though in the latter case clean skimming and hot metal would avoid most of the trouble. Such iron as this, then, is most suited for castings of light section, and here again the metal must enter the mould in such a manner that the dirt can get clear away and not be trapped between two runners, as was the case in the example shown in Fig. 2. This was overcome by stoping off one of the runners shown, when the metal passed along the mould as it entered, instead of producing a harbour for the accumulation of scum from the runner at each side.

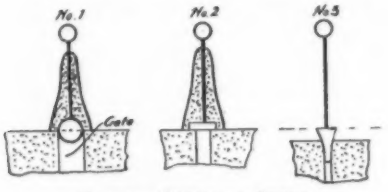


FIG. 5.—FORMS OF STOPS.

To prevent scum or dirt which simply floats on the surface of the metal is an altogether different matter, and there are several methods employed for this purpose. It is assumed, of course, that there is no dirt already in the mould, and that the runner box or basin is made up of well tempered sand without any projections which are likely to be removed by the flow of the metal. What is required now is to get the metal into the runner quickly and quietly without any of the floating dirt being sucked down the runner. This generally occurs at the commencement of casting, except in cases where the runner box, not being large and deep enough, permits of continued suction of the surface metal. There are two ways at least of introducing the metal to obtain the desired end; one is, however, risky, but the other may be regarded as sure, provided the tipping gear of the ladle is in good order. The first method, which is adopted by many moulders, is to get the ladle in as good a position as possible, and then to flush the runner box all at once, risking a big splash and fireworks, and possibly some of the floating slag (which has managed to elude the efforts of the skimmer) being carried dangerously near the mouth of the down runner. The other and better method is to have a dish in the bed of the runner box as shown in Fig. 3, to serve for a feeler for the lip of the ladle. Into this a little metal is tipped, the amount varying according to the size of runner box and weight to be poured, giving an opportunity for a gradual start without any metal running into the mould at the beginning; the runner box can then easily be flushed without a splash. It is needless to say that it is the better plan to have a ladle quite large enough to allow for a slight tilt without the metal overflowing than to have the ladle full to the top, though where this cannot be avoided stops should be used. Fig. 4 shows an undesirable method of shaping the runner basin, this being altogether too shallow, and the sides having too much slope.

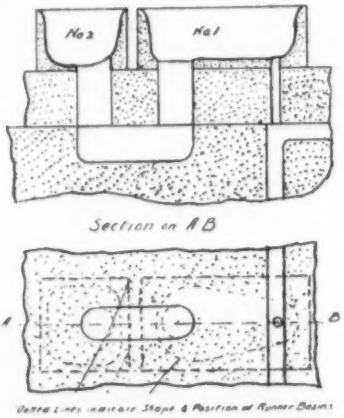


FIG. 6.—FLUSHING THE RUNNER BOX.

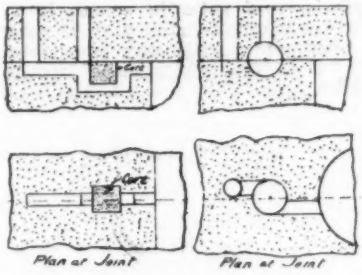


FIG. 7.—SKIMMING GATE. FIG. 8.—BALL GATE.

Many castings require the use of stops as, for example, the rims of large spur wheels or the wheels of water turbines with both cast-iron and steel vanes. In these cases, and especially the latter, it is important that good fluid metal be admitted to all parts of the mould at the same time.

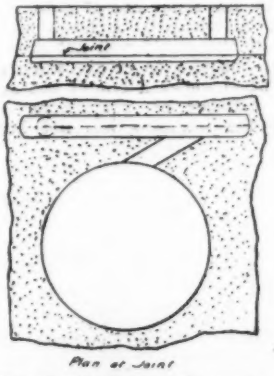


FIG. 9.—SKIMMING CHANNEL.

The runner box generally consists of two concentric rings, between which the runner is made up with sand in the form of a circle, to supply the equally spaced down gates, one, two or more places being provided for pouring in the metal. When the stops are in position the runner box can be filled with metal and if the whole of the stops are removed at the same time a uniform cast results. In moulds of great depth where, of course, a bottom runner would be employed, consideration must be given to the fact that if all the metal has to pass by that way into the mould it will be retarded consider-

ably by the metal which is poured in first, and the consequence will be (if the casting is of great length) that the further end will be imperfectly run, while at the runner end the mould will probably be severely strained. By using runners at either end, if a very great length, or by the use of auxiliary runners or gates at a higher level at the same end, this choking is avoided. Therefore it is usual to employ two or three series of stops to the runners, to be lifted consecutively as the mould reaches different stages in filling. Another point is that of providing a sufficient number of runners, all of which, however, need not necessarily be used, but to serve in case filling of the mould does not proceed at a satisfactory rate, which is sometimes the case owing to variation in the temperature of the metal. By lifting one or two stops an additional supply can then be obtained. Stops are of various shapes, but all serve the same purpose, that of plugging the mouths of the runners temporarily. The three forms shown in Fig. 5 are those in general use. No. 1 consists of a ball of cast iron having a wrought-iron rod terminating in a ring at the top cast in. The square or flat stop and the peg stop are used on

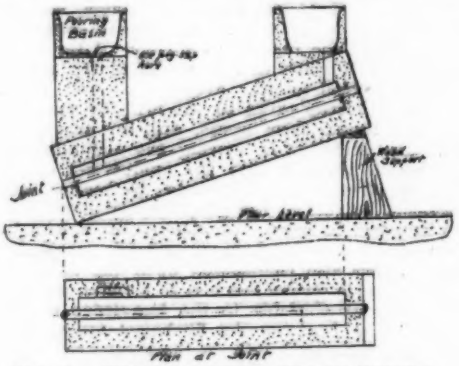


FIG. 10.—POURING A SMALL ROLLER CASTING.

smaller work, the lifting rod being similar to that of No. 1. No 2. has a square or oblong piece of cast iron at the end, and No. 3 a well-tapered plug of cast iron. In use the ball stop should fit into the mouth of the down runner of slightly less diameter for support, and where the down runner is square its upper end must be shaped to receive the ball. The flat stop simply covers the runner, and the peg stop fits into a round down runner. If the stops have to resist the flow of a large quantity of metal it is usual to protect the rod by a casing of loam, which is dried, but in all cases the stops should be dipped in a mixture of blacking and dried, being used hot, the blacking preventing disturbance and flying of the metal due to rust.

Means adopted to ensure a clean cast in small work are numerous, one being to cover the down runner with a thin piece of tinplate having it in two or three small holes over the runner, and held down by small sprigs. By the time that the runner-box is filled, the metal, aided by the small holes, makes a large hole in the cover, and is free to enter the mould. Fig. 6 shows a method by which the runner-box proper (No. 1) is flushed from underneath by a large round gate. The surface of the metal remains quite calm, and the mould receives a steady supply of clean metal from the bottom. Fig. 7 gives two views of a skimming gate, which must be provided with a large down runner to quickly fill the channel connecting it with the riser, up which the floating dirt and scum may rise, the mould in this case also receiving a bottom feed. By means of the ball gate shown in Fig. 8 the metal is given a circular motion which gathers the floating dirt in the centre, a riser being provided for its exit, the metal for the mould leaving the ball in a direction opposite to its original motion. Fig. 9 shows another form with a long channel in which the scum can rise, the metal leaving as shown in plan, in an opposite direction to that of the entering metal.

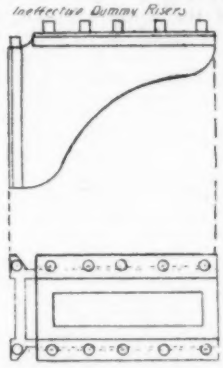


FIG. 11.—INEFFECTIVE DUMMY RISERS.

In Fig. 10 is shown a mould for a small roller cast in an inclined position and provided with a large riser to allow dirty metal to escape into the large basin shown, the resulting castings being as sound and clean as if cast vertically.

A great deal of importance is attached to the use of dummy risers on parts of the castings which have to be machined. These dummies, as they are termed, are of very little use, however, except in certain cases, as the effect is only local. For instance, in the example shown in Fig. 11, the dummies take the dirt of the iron which is directly under them. There is not sufficient agitation, however, for any dirt that may be at

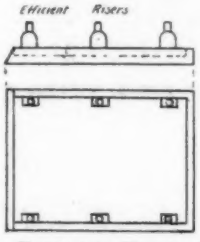


FIG. 12.—EFFICIENT DUMMY RISERS.

the surface in the spaces between them to rise into them, so, therefore, unless the dummies cover every portion of the surface, dirty places are possible. Instead of dummies, a little extra thickness for planing would perhaps be better if the surfaces were required to be very clean. In those cases where the machined surface can be cast at the bottom, this is certainly the wisest course, but in the above it is assumed that other parts require machining. Where there are a number of small snugs, or ears, which will afterwards have to be bored, a small dummy, as in Fig. 12, will be an advantage, the snugs being likely to contain a small amount of scum from the metal in and underneath it. In making a gate the better way is to ram up a pattern of the gate in the mould, instead of pushing a tube through the cope, in which case a rough face is

left, with the result that some of the sand is carried into the mould, Another source of dirt in castings, and one not always noticed, the cause being put down to dirty moulding or bad skimming, is found in the quality of facing sand employed, There may have been good skimming, good moulding, and good clean metal, but if the facing sand contains dust or burnt sand in any quantity, the mould near the gate will be severely attacked, showing in that place a rough face, and giving a dirty casting when machined on the upper surface. Very little dust and burnt sand may cause this dirt, especially if the metal is very hot and cannot get clear away. This roughness is not to be taken for scabbing, but if the amount of burnt sand and dust in the facing sand is very large, there will be a tendency to lift off the top surface of the mould in places, leaving a rough scab and a dirty surface to the casting. Shell scabs, or scabs which come off by hammering, leaving a smooth surface where they have been, are due to the sand being too close (which may be due to extreme fineness or hard ramming), or to the venting having been imperfectly done. It must seem strange to most moulders that in some cases where scabbing occurs, there is no dirt on the surface of the casting. The explanation, as first mentioned, is expansion of the surface of the mould into the casting, leaving a cavity behind which is filled with metal, there not being sufficient agitation in the mould to lift the face off completely, this metal in the cavity being the actual scab when the casting is got out of the sand. If venting has been very badly done, or the sand has been too damp, the projecting portion of the mould will no doubt be carried to the top of the casting, and leave a scab which will not shell off, as it will consist of solid metal firmly attached as a part of the casting. Hot metal increases the danger of these cases of scabbing, as it increases the volume of any contained air, and the gases evolved from the coal dust and other organic matter which the sand may contain.

The coal dust is another important element tending to produce dirty castings. If the grains are not fine enough bad effects are produced, especially in parts of the mould receiving hot metal, such as those near the gates. The coarser the coal dust the larger must be the quantity used, in order that every portion of the sand shall receive a supply, and then the remedy becomes the evil and acts as a kind of gas producer for the mould, without much of the good effects of the gas being obtained. The coal cokes and swells up; that at the face is burnt out and its ash congregates to form dirt on the surface of the casting, the parts of the mould thus attacked giving a rough face to the casting, and it is said that the metal has "eaten in," which is not to be wondered at. If the coal dust were finer the same amount would supply the needs of a greater volume of sand, and if properly distributed would be more gentle in its coking action and gas producing.

A great source of dirt is the parting sand which some moulders are in the habit of throwing on the pattern to prevent the moulding sand adhering thereto. When the metal reaches this parting sand, which it is assumed has not been removed during finishing, it carries it along with it and helps to produce dirty places in the casting by forming a slag with oxide of iron. A good plan with iron patterns is to smear them with paraffin oil, which keeps the face of the pattern from contact with the moisture of the sand. There is an objection to this, however, in some cases, as the paraffin is somewhat absorbed by the sand and very quickly evaporates when the pattern is withdrawn, accelerating the evaporation of the water also, and rendering the finishing of the mould difficult on account of the crumbly nature of the surface, which cannot afterwards be wetted in a very satisfactory manner. This is the case when the pattern is ornamental, and there is a danger of spoiling the design, so that it is better to brush on a thin coat of beeswax, this giving a very good effect.

THE VALUE OF TECHNICAL EDUCATION.—Recently the ironfounding class of the Halifax Municipal Technical College, accompanied by their teacher (Mr. R. B. Robinson) and a few friends, paid a visit to the works of Messrs. T. H. Pickles & Sons, iron and brass founders, Mythomroyd. This proved to be one of the most interesting of the visits that have been arranged by the class, for the value of education was practically demonstrated. One of the principals (who attends these classes) told the party of the great saving and economies that had been effected through putting into operation that which he had learnt at the classes. In fact, it had proved one of the best investments that had ever been made by the firm, and it was fully realised that to attain to the requirements that were demanded by users of castings at the present time, a thorough, systematic, technical education was an absolute essential to the prosperity of the founding industry. After spending one-and-a-half hours in looking round the works the party adjourned to tea. Afterwards a vote of thanks was very heartily given to the firm for showing the company round their works, and for providing the tea. Mr. Midgley, in moving the resolution, made mention of the fact that the apprentices connected with the firm had every chance to become efficient workmen, because of the great variety of work which the firm had in hand. In some places a man was a mere machine, being kept on one job practically all his life. He also commented upon the advance the firm had made during the last 18 months, an advance which was attributable to the knowledge gained by Mr. Pickles, jun., at the Technical College. Mr. Robinson spoke at length on the great need for technical education generally in foundries, but especially to the rising generation. A moulder needed more than the bare ability to ram sand and finish a mould before he was fitted for a higher position in the foundry. Mr. Rupert H. Pickles replied on behalf of the firm, and said it was quite a treat to them to receive the class at their works. He alluded to the great benefits that he had obtained by attending the classes.

A MOST interesting lecture on Boulton, Watt, and Murdock was given before the Birmingham Association of Mechanical Engineers at the Grand Hotel, Birmingham, on March 7, by Mr. R. H. Kirton, Curator of the Watt Museum, at the Cornwall Works, of Tangye's, Limited, Birmingham. It is well known that for many years Mr. George Tangye, senior partner and head of the firm, has been collecting a great variety of relics of these three famous Birmingham engineers, and there is one room in Heathfield Hall, Mr. Tangye's residence, and formerly occupied by Watt himself, which remains exactly as it was left by the inventor of the steam engine. Portraits of the three Birmingham worthies with drawings of Watt and Murdock and models of their engines were thrown on the screen, as well as of Watts' indicator and Murdock's locomotive. Numerous letters by Boulton, Watt, and Murdock were also shown, some dating as far back as 1777. The slides numbered 100, of which three portrayed the museum itself, so well and carefully preserved by Mr. Tangye. This gentleman gave a brief but very interesting chat on historic Heathfield Hall, and the famous workshop garret of Watt.

The Equipment of the Grinding Department.

A Consideration of various Abrasives and Grinding Machinery suitable for Foundry and Foundry Machine-shop Purposes.

A somewhat neglected department in many foundries, but nevertheless an important one, is that in which the castings are ground up to their required fitness and cleanliness for dispatch. The success of the whole plant may depend on the way in which the castings are finished, for nothing so forcibly creates the impression of slovenliness and careless workmanship as untidily finished castings, and a foundry that gets such a reputation is not likely to prosper, no matter how carefully the other departments may work in producing the castings. It is needless to say, too, that though a badly equipped grinding shop may, by dint of much endeavour and conscientiousness on the part of the operators, turn out nicely finished castings, this is done at a considerable cost in time and labour. Out-of-date machinery may be expensive to replace with modern appliances, but, generally speaking, it is more expensive to keep, if good work is required. In the following pages it is proposed to briefly describe and illustrate some modern grinding appliances, suitable for general foundry work.

In equipping a foundry with grinding apparatus there are several points to be considered. The machines must adequately deal with the work that is being turned out; they must not encroach too much on the floor space of the works, particularly where this is limited; they must be of the design that will most economically deal with the work, and be suitable for whatever driving power is available, either electric or shafting from a steam or other engine; and there must be a sufficient selection and supply of the apparatus to meet the various demands of the whole of the works. Not only must the dressing shop be considered, but also the machinist and the pattern-maker, who frequently require to use a grinder for their tools. It is often desirable to arrange a system of dust exhaustion to deal with the dirt and dust produced at the wheels. There are a number of systems available, operating by fan-blast and other means, but we do not propose to enter into that side of the subject at present. In some of the machines illustrated a system of dust exhaust is shown attached.

Characteristics of Grinding Wheels.

Wheels used for abrasive purposes have two distinguishing characteristics, either or both of which may be varied according to the class of work to be done. These are the fineness and the hardness of the wheel. Fineness is dependent upon the size of the grains of the grinding material, and is commonly known as the "grit." The different degrees of fineness or "grits" are, in the case of manufactured abrasives, indicated by numbers. The selection of the proper grit for any work depends upon the smoothness of finish required and the amount of material to be removed in a given time, when finish is not important. Hardness, as the term is understood by makers of grinding wheels, is the quality of resistance to crumbling away which such wheels possess. The degree of hardness, called the "grade," is generally indicated by a letter, chosen arbitrarily with reference to certain standards. The different grades are produced by varying the binding material used to hold the grains together. The selection of grade depends upon the character of the material to be ground. A wheel which is too hard heats the work, glazes, and will not cut. If it is too soft it cuts rapidly, but at the same time wears away fast. To successfully meet all the conditions to which wheels are subjected, manufacturers make them in a number of degrees of hardness, letters arranged in a scale being generally used to designate these degrees.

When selecting a wheel for any kind of work, three considerations should determine the choice:—(1) The rapidity of grinding or cutting desired; (2) the total amount of work to be performed; (3) the finish to be produced.

These three elements are usually of value in the order here given. The speed of a wheel and all other operating conditions being the same, they are influenced as follows:—(1) The rapidity of cutting is increased by using a coarser grit or a softer grade; (2) the total amount of work performed by a wheel is increased by using a finer grit or a harder grade; (3) the finish produced by a wheel is increased by using a finer grit together with a softer grade.

Grindstones.

Until comparatively recent years the deposits of millstone grit which occur in this country served to furnish grindstones for all purposes. The immense deposit of millstone grit is one of the most important geological features of Derbyshire. The formation extends from the extreme north to a point within some ten miles of the southern boundary, but it is in the part immediately around Matlock that the grindstone industry is most active. Here is found some of the very best grit for all kinds of work, the grades varying, even in one quarry, from fine to very coarse and from very hard to soft. In choosing a grindstone price is not the only factor to be considered; the quality of the work, the time occupied in doing the work, and the life of the stone, are all points of first-rate importance, and a careful choice on the advice of an expert is advisable. Derbyshire stones are very popular among stove grate makers particularly. Other districts also are favoured with natural supplies of excellent stones for abrasive purposes. Lately, however, other harder abrasives have, to some extent, though by no means entirely, superseded the natural stone deposits. For many purposes, of course, emery has long been in use, but even that material is now giving place to a purer form of itself, corundum.

Emery Wheels.

Emery has only 20 to 40 per cent. of free crystalline alumina, as compared with 95 to 98 per cent. in the Canadian corundum referred to later. Emery wheels are generally made by three distinct processes. The first, by mixing the grains of emery with vitreous clays and other silicious and alkaline materials in proper proportion, shaped in moulds and burned in a potter's kiln. The second, by mixing emery with various cohesive substances and pressing between hot plates by hydraulic machinery. The third, by mixing with a mineral bond such as silicate of soda, and drying with a gentle heat until suffi-

ciently hard to use. The first-named process is now rapidly superseding all others.

Among the advantageous characteristics of wheels made by this process, it is claimed that they cut faster and more freely, do more work, and hold their shape better than the glutinous cement wheels. The bond is of the nature of a hard porcelain, and the wheel has less weight than any other kind of wheel, and is therefore less liable to burst. It can be hard or soft, and of any degree of fineness or coarseness desired to adapt it to every kind of work, and can be run equally well wet or dry, and successfully resists the action of either oils or acids.

Corundum.

Corundum is one of the hardest substances in the world; it is earth aluminium found native in a crystalline state. Emery is an impure form of corundum. It contains about 20 to 40 per cent. of corundum (free) crystalline alumina, the remaining 60 to 80 per cent. being oxide of iron, silica, etc., and also combined alumina, which last has no cutting power. The 20 to 40 per cent. (the corundum) cuts, while the 60 to 80 per cent. rubs and burns. This is why an emery wheel will glaze; it is why it will destroy the temper of a steel tool. Corundum itself is a cold cutter; it takes a clean bite without rubbing.

Until the discovery of the Canadian deposits, pure corundum was practically unobtainable in commercial quantities, although some corundum was obtained in small quantities from North Carolina and Georgia. These deposits in the United States, however, are of a secondary or derived origin, and hence pockety and uncertain; the corundum in them also varies in quality and physical characteristics.

The hardness and cutting efficiency of corundum depends chiefly upon three things:—(*a*) The absence of chemically-combined water; (*b*) the absence of lime; (*c*) the crystallisation. Other things being equal, the less water there is chemically combined with corundum the harder it is. If there is much water chemically combined, it becomes soft, and is known as disapore. Dr. Lawrence Smith ("American Journal of Science") showed that corundum having 2.86 per cent. of combined water had an effective hardness of only 58, while corundum having 1.60 of water had an effective hardness of 77 (sapphire of India, a gem variety of corundum, being the standard, 100). Crystal Canadian corundum has only 1.22 per cent. of water, and has an effective hardness of 94. This exceeds that of any other commercial corundum.

FIG. 1.—SINGLE WHEEL GRINDING MACHINE FOR HEAVY WORK.

Lime, next to chemically-combined water, is most destructive of the cutting qualities of corundum, causing it to become laminated and also to disintegrate. Crystal corundum is shown by the analyses to contain no lime, and when it is crushed it presents sharp edges, not flat surfaces. Unlike emery, the coarse sizes need not be mulled, hence the sharp edges are not worn off. Crystallisation intensifies the hard-

ness, and gives the abrasive the property of cutting cool without destroying the temper of steel tools, etc. Manufacturers of wheels speak of hard and soft wheels. This does not mean that some of the corundum is hard and some soft, it simply refers to the amount of bond in the material used to form the wheel.

Carbo-Corundum.

Carbo-corundum is manufactured by an electro-chemical process. It is artificial corundum, and is harder than emery and natural corundum. It is infusible, except at a very high heat, and is insoluble in all liquids. Carbo-corundum, unlike emery, is free from all substances having no grinding properties, emery having a large percentage of magnetic metal in its composition which diminishes its hardness and grinding qualities. The grain of carbo-corundum is of an irregular crystallisation; it is comparatively brittle, but has no lines of cleavage, and when it breaks does not become round but leaves sharp, irregular grinding points, thus always retaining its grinding power during the grinding process. Carbo-corundum wheels, properly graded, therefore do not glaze or render the work hot as emery wheels do. This material is rather more expensive than emery, and is manufactured in all shapes, and for all purposes for which abrasives are used.

Carborundum as an Abrasive.

Carborundum is a manufactured abrasive—a chemical combination of the two elements, carbon and silicon. It is the trade name given to carbide

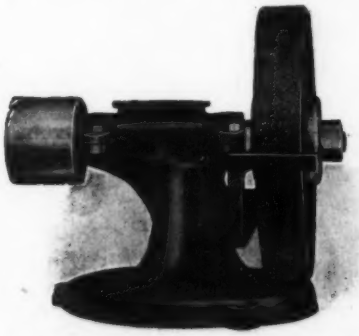


FIG. 2.—BENCH GRINDING MACHINE.

of silicon—a substance not discovered but actually created by Edward G. Acheson in 1891. It ranks amongst the very hardest of abrasives, and possesses great durability. It is made up of small, sharp crystals that are just brittle enough to break slightly in use. The sharp edges of the crystals cut clean and fast; while the brittleness, by constantly presenting fresh cutting edges, prevents glazing. The combination of these qualities—durability, rapidity and uniform efficiency—makes carborundum one of the best of all known abrasives.

The principal materials entering into the manufacture of carborundum are coke, supplying the element carbon, and sand, supplying the silicon. The coke is crushed in a mill and is then mixed with the sand. After being subjected to several other details of treatment, the mass of raw material is placed in an electric furnace and the current turned on. The furnaces used carry a current of 2,000 electrical horse-power each, and the furnace run is 36 hours. The total energy used in a single run of a carborundum furnaces is therefore 72,000 horse-power-

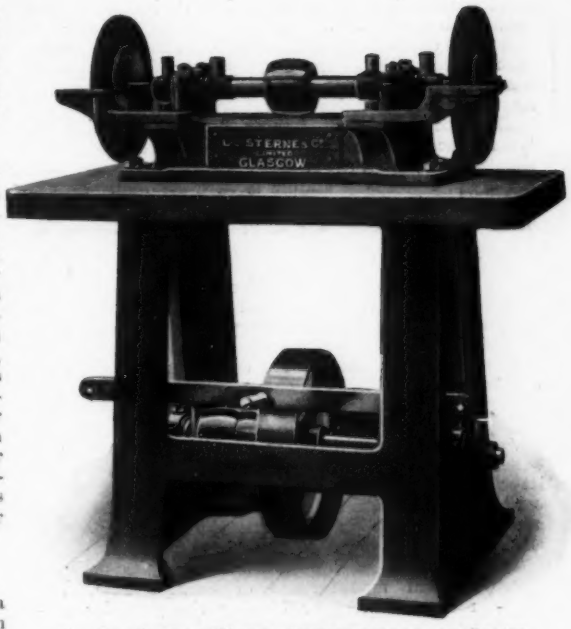


FIG. 3.—DOUBLE WHEEL GRINDER-HEAD, ON STAND.

hours. The electrical current, which is brought to the furnace by means of large copper bars, is obliged to pass through the furnace along a path of high

FIG. 4.—GRINDER FOR DRY WORK.

resistance, which results in the generation of enormous quantities of heat, the temperature of the resistance path and the surrounding mass of coke and

sand being raised to a point which is between 7,000 and 7,500 degrees F. At this heat all the impurities and substances in the coke and sand other than carbon and silicon are destroyed or driven off in gaseous form and the atoms of these two elements fly together and unite as carborundum.

The electric current having been passed through the furnace for a sufficient length of time to produce the desired results, the furnace is allowed to cool and the crystalline carborundum is then exposed. This is then crushed, subjected to various forms of treatment and the product graded as to size from the coarsest grain to an impalpable powder. It is thus possible to obtain in the manufactured forms in which it is marketed any desired coarseness or fineness of cutting, grinding or sharpening surface, which may be required for definite purposes. The only material difference between two carborundum wheels is the difference between the coarseness and fineness of the grain.

Carborundum is insoluble in water or in any known acid. This is an invaluable property in any grinding material, as the use of water expedites the work and catches almost all of the dust. The two characteristics of hardness and sharpness taken together make carborundum an ideal abrasive or grinding substance, and it is for this purpose that the greater part of the carborundum produced has been used.

Immediately following the solution of the problem of commercial manufacture of carborundum, the question of cementing or binding the granular material into forms and shapes convenient for grinding purposes presented itself, and more particularly so in reference to the forming of wheels to be used as a substitute for emery and corundum. A careful investigation of the methods employed by the emery manufacturers disclosed the fact that no less than seven were used by the several companies, designated as vitrified, silicate, celluloid, vulcanite, asphaltum, shellac and tanite processes. Of these, the vitrified process is regarded as the most scientific and efficient, as in it the binding material employed is in itself a fairly good abrasive, whereas, with the other six processes substances are employed which are decidedly injurious to the wheel, in some cases causing a gumming or glazing, and in others a softening when exposed to moisture. The binding material employed for wheels of carborundum being insoluble in water, the wheels run equally well wet or dry.

FIG. 5.—HEAVY SINGLE WHEEL GRINDER.

Mounting and Care of Grinding Wheels.

It must not be thought that as soon as the grinding equipment is installed there is nothing more requiring special attention. The care and inspection of the wheels from day to day is a most important matter, particularly where high speeds are the rule, or the disasters which are from time to time reported in connection with wheels bursting, and so forth, will be unduly courted.

When mounting a grinding wheel it should be fixed carefully and securely between iron plates or washers about half the diameter of the wheel, with a sheet of thin rubber insertion, or one or two thicknesses of brown paper, on each side between the wheel and the washer-plates. It

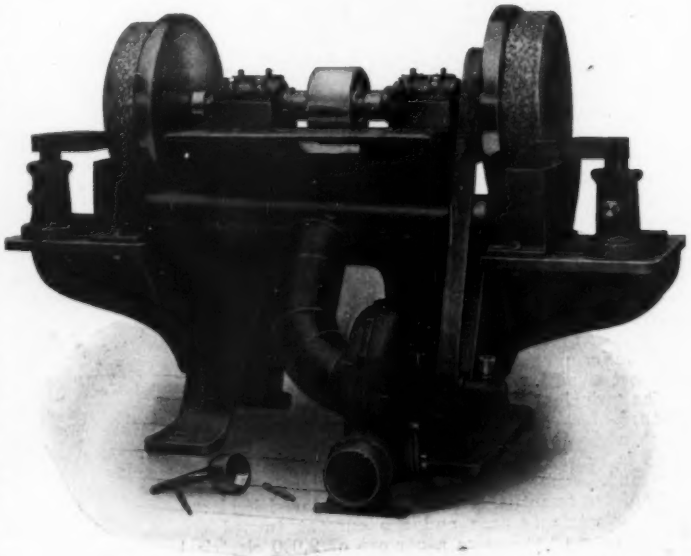


FIG. 6.—DOUBLE UNIVERSAL FACE WHEEL GRINDER FITTED WITH DUST EXHAUST.

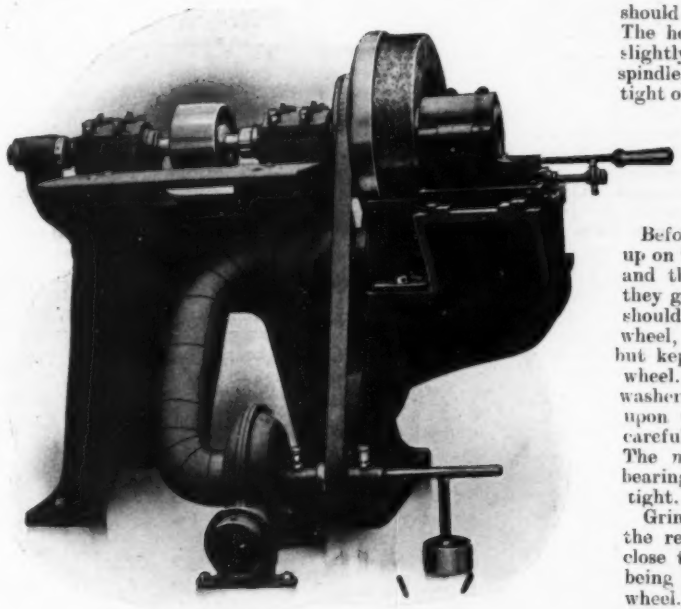


FIG. 7.—SINGLE FACE WHEEL GRINDER.

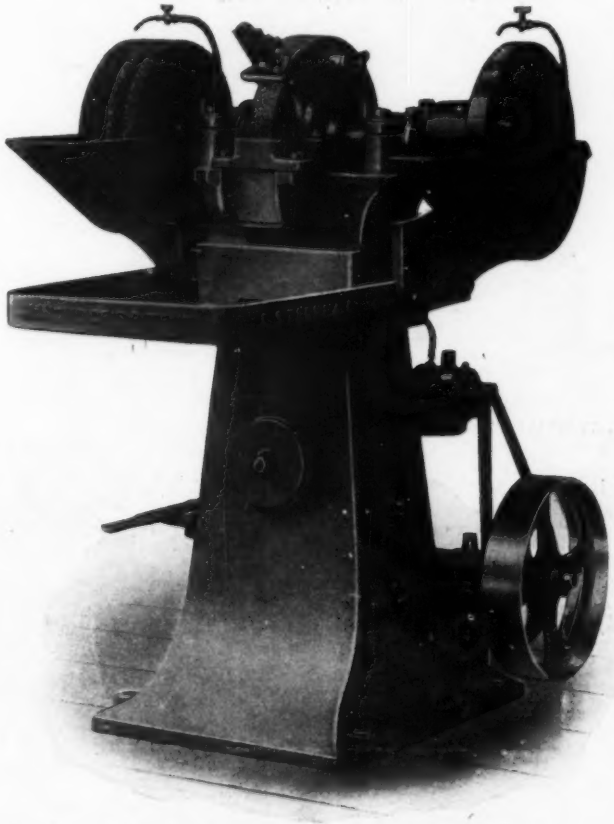


FIG. 8.—TOOL GRINDER FOR PATTERN MAKERS.

should never be mounted without washers. The hole in the grinding wheel should be slightly larger than the diameter of the spindle, as the wheel must not be driven tight on to the spindle. Care should be taken in screwing up very thin wheels that too much force is not applied. No wheel of more than 12 in. diameter should be put on a spindle 1 in. thick, and other sizes in proportion.

Before using, the wheels should be trued up on their own spindles with a truing tool, and they should also be turned up when they get out of truth through wear. Work should not be pressed too heavily on the wheel, and should not be kept in one place, but kept moving across the face of the wheel. The grinding wheels, as well as the washers, bolts, and journals of the machine upon which they are mounted, should be carefully examined at least once every day. The machines should be kept clean, the bearings well oiled, and all bolts and nuts tight.

Grinding wheels should revolve towards the rests, and the rests should be moved close to the wheels so as to prevent work being jammed between the rest and the wheel. The rest must never be moved while the wheel is in motion. No oil or grease should be allowed to get on to the working surface of a grinding wheel; when using wheels wet, a little carbonate of soda added to the water tends to prevent the surface of the wheel from getting greasy, and keeps it in a clean cutting state.

A common mistake made by grinders is in expecting one grade of wheel to do a great variety of work. A wheel that is admirably adapted for one class of work will prove quite inefficient for another class, so it is advisable to keep at hand, if possible, wheels of several grades. The greater economy effected will more than recoup the extra outlay involved, and the work done will be far more satisfactory.

Coarse wheels are less liable to change the temperature of the work, or to glaze, than fine ones, while if a wheel is too hard the temper will be drawn from the tools. Soft wheels are best for grinding hardened steel, brass, copper, etc., or for thin-edged tools. A medium grade should be employed for removing surplus metal; for grinding lathe and planer tools a harder grade should be used, while for pointing wire, or grinding between the grooves of taps and reamers, a wheel much harder still is required. As a rule, the harder the stock the softer the wheel required to give a certain finish, and the denser the wheel the greater the speed at which it may be run.

Grinding Machinery.

Having now discussed the characteristics of the various materials which are available as abrasives, we will briefly describe and illustrate some typical modern grinding machines and appliances.

The machine shown in Fig. 1 is by Messrs. L. Sterne & Company, Limited, of Glasgow, and is designed for carrying a single large wheel for grinding heavy work. This form

of machine allows the greatest freedom about the grinding wheel, which in the one shown is 36 in. diameter by 4 in. The machine can also be supplied without the rest, as shown, and to accommodate wheels up to 6 in. thick.

A small single wheel bench grinder, taking emery wheel from 9 in. by 1¼ in. to 12 in. by 2 in., and suitable for all kinds of light grinding and polishing, is shown in Fig. 2. A machine of this type can easily be attached to a bench or other support, and, for small jobbing shops, brass-foundries, etc., is particularly valuable. This machine is made by Messrs. B. R Rowland & Company, Limited, Reddish, and the one shown in Fig. 3, which is adapted for similar work, by Messrs. L. Sterne & Company, Limited. Either of these heads can, of course, be fixed on a stand fitted with the counter-shaft for driving. The position of the grinder in the shop will decide which of these two methods is better. In the case of the stand the floor space occupied is practically the same as the over-all measurements of the grinder head.

Fig. 4 illustrates a very useful form of grinder manufactured by Messrs. B. R. Rowland & Company, Limited, of Reddish. These machines are suitable for any class of dry grinding, such as dressing castings, grinding ends of iron and steel bars, etc., their chief feature being the small amount of floor space required. This type of machine is strong and substantial, consisting of a massive cast-iron stand carrying a strong steel spindle fitted with an emery wheel mounted on safety dovetail plates. The bearings are extra long, of large diameter, and run in self-oiling ring-lubricating dust-proof bearings. A water-tight partition is arranged through the body, thus forming a receptacle for a small depth of water, which catches the dust of grinding, and very effectually reduces this nuisance. A cupboard may be arranged below the partition, the machine being fitted with a door for this purpose. This machine may also be arranged, if desired, for an exhaust fan attachment similar to that shown in Figs. 6 and 7. The illustration shows the machine fitted with a wrought-iron adjustable safety guard.

A heavier style of machine for grinding castings is that shown in Fig. 5. This carries a single wheel and is driven from a separate overhead countershaft.

An interesting machine is that depicted in Fig. 6. This double universal face wheel grinder is one of Messrs. Rowland & Company's heavier designs, and is made in sizes suitable for carrying grinding wheels from 16 in. up to 36 in. diameter. These machines are of very heavy and massive construction, having extra long bearings of large diameter running in self-oiling ring-lubricating bearings. They are suitable especially for heavy work with flat surfaces. The machine shown in the illustration is fitted with a complete dust-exhausting apparatus, the fan operating the exhaust being driven, as shown, from a pulley on the grinder spindle by means of a short belt.

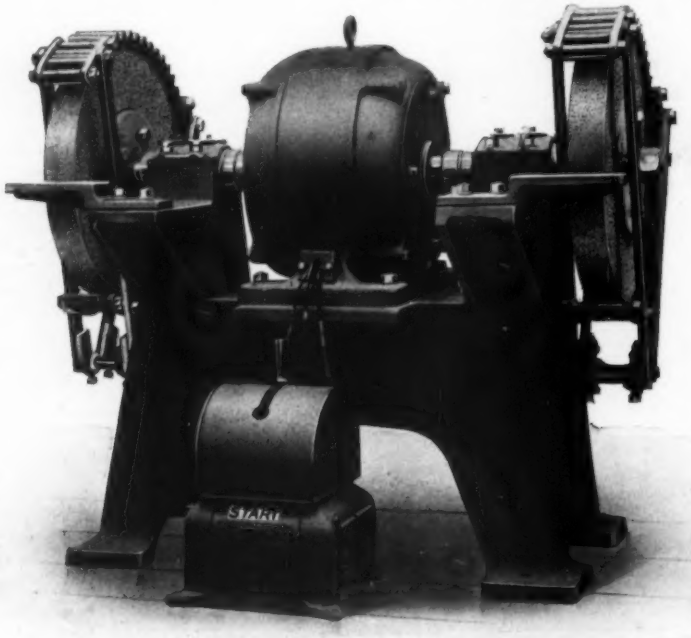


FIG. 9. DOUBLE-WHEEL GRINDER, ELECTRICALLY DRIVEN.

The single wheel spring grinder, shown in Fig. 7 (Messrs. B. R. Rowland & Company, Limited) is also fitted with a self-contained dust-exhausting apparatus, driven in the same manner as the machine previously described. This machine consists of a strong cast-iron stand fitted with a steel spindle carrying a face grinding wheel. The spindle runs in self-oiling ring-lubricating bearings, the end thrust upon the grinding wheel being taken up by means of a tail-pin at the opposite end of the spindle. The side table is planed and fitted with an adjustable rest. The particular machine illustrated is fitted with a special spring holder, mounted on a reciprocating slide rest fitted with cross feed. This arrangement has been

specially designed for grinding the ends of spiral springs.

Since the pattern-maker also must be catered for in respect to grinding apparatus, we illustrate a machine specially designed for dealing with wood-workers' tools. The ordinary stone or emery wheel serves for a good many of the pattern-makers' tools, such as plane-irons, chisels, and all flat tools, but for the numerous gouges, moulding-irons, and shaped tools that are included in his kit something more is needed—that is, if accuracy in grinding and economy in time are any considerations. On the machine shown in Fig. 8, the four thinnest wheels on the left-hand side have rounded faces for gouges, moulding-irons, etc., the thickest wheel in the centre has a square face for plane irons, chisels, etc., and the wheel on the right-hand side of the machine is an emery hone ring. A centrifugal water pump is fitted, so that the temper of the tools is not injured by the grinding.

For shops where electric power is available the system of driving shown in Fig. 9, is very applicable. This method may be applied to any of Messrs. Rowland & Company's standard universal grinders, one of which is depicted in the illustration. Any type of electric motor can be adopted that may best suit the requirements of the purchaser. For cases where grinding is required to be done away from the proximity of a line shaft, this machine is very desirable.

(To be continued).

Calculating the Average Price of Castings.

By Dr. R. Grimshaw.

If there is any one thing on which the cost calculator can trip, it is averages. Some, for instance, if the lightest casting in the place costs one penny per pound to make, and the heaviest a farthing, set down the average cost of castings of all weights as ½d., entirely irrespective of how many pounds or tons of each the foundry produces. Others, wishing to be more accurate, figure up as carefully as they can the cost of one piece of every separate weight, and average them. But here again they do not strike it: for one piece of 150 pounds would run up the average of the whole output, which might be almost exclusively of lots of a hundred each of pieces under ten pounds.

A better way—still, not perfect, and no exact way can really be devised—is first to work up a table showing the cost of the melted iron for each weight. This, by reason of the varying loss in sinking heads, drip, etc., may be for one weight of casting 5 per cent., but for another two hundred. The ruling of this table is in the Loewe establishment in Berlin as follows:—

(The writer has added the upper "per cent. of waste" line.)

Per cent. of waste.	Cost of Pig. Marks (shillings).	Melters' wages. Marks (shillings).	Coke. Marks (shillings).
0	8.50	—	—
5	9.22	0.23	0.45
10	9.49	0.24	0.46
15	9.61	0.25	0.48

Materials and other wages are figured as a percentage of the moulders' and core-makers' wages, distributed, say, as follows:—

	Per cent.
Wages (other than melters')	35
Fuel for drying moulds	2
Moulding sand and core sand	6
Various materials (flour, blacking, etc.) ...	19
Total	62

We now have some data from which to start a table which can embrace every weight of casting in the establishment. This table the author arranges as follows:—

		I.	II.	III.	IV.	V.
Weight	kg.	800	125	30	6	1.5
Moulders' wages	Marks.					
Core-makers' ,, ...	,,					
Cleaners' ,, ...	,,					
Waste					Per 100 kg.	Per 100 kg.
		100 kg.	100 kg.	100 kg.	100 kg.	100 kg.
1 Moulders' wages						
2 Core-makers' ,, ...						
3 Cleaners' ,, ...						
4 Melters' ,, as per scale						
5 Helpers' ,, (35 per cent. for Classes I. and II)						
6 Iron as per scale						
7 Coke for melting, as per scale						
8 Drying fuel (2 per cent. for Classes I. and II.)						
9 Moulding and core sand (6 per cent. for Classes I. and II.)...						
10 Miscellaneous materials (19 per cent. for Classes I. and II.)						
Total						
General Expenses (25 per cent.						
Grand Total ...						

As fast as these cards are filled in, they are arranged according to weight, so that from the various columns on a sheet having the same side items, but from twenty to fifty columns for castings of different weights filled in beforehand, progressively arranged, there will gradually result a table which will give a much greater approximation to accuracy than is usually attained.

Cards like No. 1 can be filled out to suit various prices of iron, coke and wages; and if any one of these rises or falls materially, new cards No. 2 and new tables No. 2 may be added, keeping the old ones to be used again in case of change to the old conditions.

All the items need not be re-calculated; if there is a rise of 10 per cent. in melters' wages, that will be 10 per cent. of 35 per cent., or 3.5 per cent. increase in total wages.

Notes on the Preparation of Phosphor-Bronze for Castings.

By A. Napier.

The introduction of phosphorus as an addition to the bronzes is of comparatively recent date, but phosphor-bronze has now become one of our most important industrial alloys, and has now taken the place of ordinary bronze for quite a number of purposes, particularly where strength is a matter of importance.

Phosphorus, which is a soft, translucent, colourless solid of a waxy consistency, is obtainable in the form of sticks about the size of a finger, which weigh about two ounces each. The specific gravity of the substance is 1.83, and the melting point 111 deg. Fahr., at which temperature it will take fire of its own accord, if left exposed to the air. On this account it is somewhat dangerous to handle with the naked hand. It should be kept in water in sealed or stoppered bottles and is best removed with tongs. In order that it may be safely handled it can be treated so as to deposit on it a thin coating of copper. This is done by placing the sticks of phosphorus in a dilute solution of sulphate of copper for about 30 minutes. This solution may be kept in a

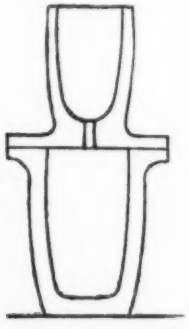


FIG. 1.—APPARATUS FOR MAKING PHOSPHOR-COPPER.

stone jar, and the phosphorus on being removed should be dried on blotting paper or rolled in sawdust.

The addition of phosphorus to bronze has a remarkable effect on its properties; the properties of phosphor-bronze, in fact, are so different to those of ordinary bronze that the two may be regarded as different metals for practical purposes. The tensile strength is increased, the limit of elasticity is greatly raised, and the power of resisting repeated stresses is largely increased. The addition of phosphorus to the metal for casting purposes also increases its fluidity. The action of phosphorus on copper and bronze is also that of a deoxidiser; the oxygen of the oxides of the metals, intermixed in the mass of the molten alloy, is consumed by the phosphorus present, thereby reducing the oxides to the metallic state. The anhydrous phosphoric acid so formed, being eliminated from the molten metal mass, the latter changes from a combination of metals intermixed with impurities, into an alloy of pure metals. The oxide of phosphorus thus formed passes into the slag, to be skimmed off.

The phosphorus may be added to the metal in the free condition, but in that form, though it combines readily with both copper and tin, it does not give such a certain result as when added in the form of phosphor-copper or phosphor-tin. If added in the free condition a greater amount of phosphorus is likely to be lost in the process, and the final alloy is not so regular in its composition.

Phosphor-Copper.

This alloy is made by melting together phosphorus and copper, and is obtainable commercially with a phosphorus content of up to 16 per cent. It is a hard, brittle substance with a white metallic fracture, and under the microscope is shown to consist of two constituents. There are various methods of adding the phosphorus to the molten copper, one way being to place the phosphorus in a tube of fireclay or graphite attached to the end of an iron rod, the phosphorus being held in the tube by means of strips of tin or copper. On this tube being placed in the metal the phosphorus is absorbed. An iron holder with a tubular end can also be used; the phosphorus is placed in the tube and the holder is then gently tilted and lowered into the metal, where it is held until the phosphorus has been absorbed.

These methods involve the loss of a considerable amount of phosphorus, but this loss is largely avoided by the use of an apparatus described by Hiorns. This consists of a flanged crucible upon which is placed another of the form shown in Fig. 1, with a hole connecting the two. The phosphorus is placed in the lower vessel and the molten metal poured into the upper one, from which it passes through the connecting hole on to the phosphorus below. Any phosphorus vapour which escapes combination with the metal in the lower crucible is caught as it passes through the upper one.

The direct methods of forming the alloy are most commonly used, but it may be prepared by reducing phosphates in the presence of copper. One method of doing this is as follows:—4 parts of super-phosphate of lime, 2 parts granulated copper, and 1 part finely pulverised charcoal are heated in a crucible at a moderate temperature, when the phosphor-copper with a phosphorus content of 14 per cent. collects at the bottom. Another method is to add phosphorus to a copper-sulphide solution and boil, adding phosphorus so long as copper-phosphide is precipitated. The precipitate is then collected, carefully dried, melted, and cast into ingots. The substance should be quite black.

In the direct method of making the alloy, when phosphorus is added to the copper, the colour rapidly changes until about 15 per cent. of phosphorus is present; at that point the colour is blue grey, and the metal very hard and brittle. From 10 to 15 per cent. is the usual amount of phosphorus contained in

commercial phosphor-copper. Phosphor-copper has the advantage of being suitable for use as a deoxidiser in alloys containing no tin, such as yellow brass, etc.

Phosphor-Tin.

Phosphor-tin is made by melting tin separately and adding the phosphorus in a similar manner to the direct process of making phosphor-copper. Another method of making phosphor-tin, and one that involves less waste of phosphorus, is as follows:—Pure Straits tin is prepared in the form of sponge tin by pouring from a height of several feet into a tub supplied with running water, after which the tin is removed and thoroughly dried. The object of this is to break up the tin into a divided form, as distinct from the close ingot metal; to prepare it in the form of fine shavings serves equally well. The phosphorus sticks or cakes are prepared, shortly before using, by being coated with a copper deposit, in the same manner as described previously, and the requisite amount is placed in the bottom of a plumbago crucible. The dry sponge tin is then placed on top, charcoal is added, and the lid of the crucible tightly sealed with a mixture of loam and fireclay. On the crucible being heated slowly the phosphorus cuts the tin and combines with it, after which the metal is skimmed and poured into suitable moulds and set in running water. The moulds should preferably be of small size for convenience in melting again with the copper to form the mixture. A somewhat similar method employs spongy tin from a solution of tin chloride ($SnCl_2$), in which a bar of zinc has been placed. The spongy tin is first collected and washed, three parts of stick phosphorus are placed in the bottom of the crucible and covered with 100 parts of this yet moist tin sponge, and the whole pressed tightly. The crucible is then heated gently until the phosphorus flames are no longer observable. The resulting phosphor-tin which collects at the bottom is coarsely crystalline, and melts at 700 degrees Fahr. Another method is to take three parts of phosphoric acid (anhydrous), six parts of tin, and one of carbon, and melt in a crucible. Commercial phosphor-tin, as usually employed in making phosphor-alloys or in deoxidising copper alloys, generally contains from 10 to 15 per cent. of phosphorus. It is extremely brittle and crystalline, with a metallic lustre. Examination under the microscope shows two constituents—a ground mass of metallic tin through which are scattered crystals of a phosphide of tin in a plate-like formation.

Preparation of Phosphor-Bronze.

When preparing the phosphor-bronze mixture for casting, the copper should be melted first, under a good covering of charcoal, to prevent it oxidising, and the required quantity of tin, zinc, etc., then added. When this is completely melted sufficient phosphor-copper or phosphor-tin to introduce the required amount of phosphorus should then be added, the whole then being stirred with a bar of graphite or of retort carbon, in order to insure the phosphorus being intimately mixed with all the copper in the crucible. The scoria and charcoal should then be carefully skimmed off and the metal poured before a skin forms on the surface. In remelting ordinary phosphor-bronze the same precautions should be taken, and if the phosphorus content has been reduced too much, as shown by a dull surface to the molten metal, a little phosphor-copper should be added to clear it.

It must not be understood that the phosphor content of the ultimate bronze will at all approximate to the amount contained in the phosphor-copper or phosphor-tin introduced into the metal. Owing to the action of the phosphorus on the oxides, as previously explained, an indefinite amount is lost, both in the making of the phosphor-copper and in making the final mixture prior to casting. Some specifications stipulate the amounts of the copper or tin phosphide to be used, but on account of the feature just mentioned this is not satisfactory if definite results are required in the final casting.

It is often, indeed, the case that the final bronze contains no phosphorus, or only a trace, owing to it having been driven off in the accomplishment of its duties as a deoxidiser. For many purposes, however, a definite amount of phosphorus is stipulated. As an instance, the British Admiralty specification for phosphor-bronze demands the following:—Copper, 90 per cent.; tin, 9.7 per cent.; phosphorus, 0.3 per cent. This gives an alloy with a tensile strength of over 38,000 lbs. per square inch, and an elongation of 15 per cent. in 6 in. For phosphor-bronze castings, to give an ultimate tensile strength of over 17 tons per square inch and an elongation on 2 in. of not less than 20 per cent., A. Philip (Institute of Metals) proposes the following specification:—Copper, 90 to 92 per cent.; tin, 7.4 to 9.7 per cent.; phosphorus, 0.3 to 0.6 per cent. This, it will be seen, is close to the British Admiralty specification.

The percentage of phosphorus required for bearing metals is higher than for some other classes of work, and in the finished castings may range to over 1.0 per cent., some typical mixtures being: Copper, 79 per cent.; tin, 10 per cent.; phosphorus, 0.3 to 1.0 per cent. The amount required for other castings varies considerably, from a trace up to 2 per cent. Mixtures commonly employed for valves, pumps, propellers, steam and boiler fittings, etc., contain from 3 to 10 per cent. of tin and from 0.5 to 0.7 per cent. of phosphorus, while for worm-wheels, cylinders, motor gearing, valves, pumps, etc., requiring a harder metal, suitable mixtures are obtained with from 10 to 12 per cent. of tin, and from 0.7 to 1.0 per cent. of phosphorus. For exceptionally hard wear the same amount of tin with the phosphorus increased up to 1.5 per cent. gives a very hard, but not brittle, alloy. Such mixtures find employment for bearings, slide valves, and other parts subject to great wear.

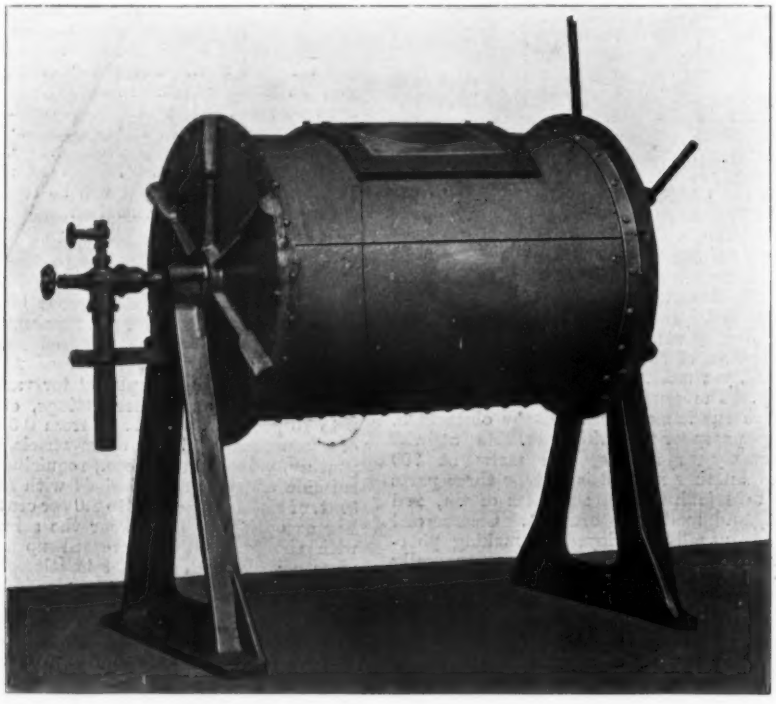
As regards the amounts of phosphor-copper or phosphor-tin which are necessary to give specified amounts of phosphorus in the ultimate castings, it is very difficult—in fact, almost impossible—to state this, as the additions will depend on the particular practice adopted. Some founders appear to lose a much greater percentage of the phosphorus introduced into the metal than is the case with others. The purity of the copper employed, also, as will be evident, must necessarily be very influential in determining the amount of phosphorus that is either driven off during the deoxidising process or retained as a constituent of the alloy. For general deoxidising purposes, however, if 0.1 of the tin used in the bronze mixture be replaced by that amount of phosphor-tin, the alloy will be materially improved. But for obtaining a definite phosphorus content in an alloy, it is best for the founder to personally determine the required additions, which will be governed by the conditions under which the work is carried out. A little experience and experiment will soon give the desired information. In passing, it may be mentioned that the reason why so many phosphor-bronze castings are made in dry sand moulds, is that the metal, when poured hot, tends to eat into the face of the mould and so produce rough castings.

Foundry Plant and Equipment.

"Empire" Rolling Metal Melting Furnace, Oil Fired.

Messrs. William Mills, Ltd., Atlas Works, Grove Street, Smethwick, have installed two "Empire" furnaces by Messrs. Alldays & Onions, Ltd., of Small Heath, Birmingham. These have now been in operation for some time to the satisfaction of the users, and as this type of furnace embodies several new features, a description will no doubt interest our readers.

The body of the furnace is constructed of heavy steel plates, and the ends are formed with cast-iron plates. It is mounted upon cast-iron standards having split bearings, thus allowing the furnace body to be picked up by a crane when desired and the metal poured direct into the moulds—a distinct advantage in many foundries. For emergency cases in the ironfoundry it is also very useful, as a charge of cast iron, up to say 1,200 lbs., can be melted in a very short time—approximately 80 to 90 minutes. It is claimed that this type of furnace is less expensive in operation than any other, there being no crucible required and the heat coming into direct contact with the metal. It is lined with best-quality fire-bricks, which when worn out are easily renewed. The furnace being fitted with a moveable plate fixed round the pouring hole, the pouring brick, which of course suffers the greatest wear, can be readily replaced without interfering with the rest of the lining. The importance of this special feature will be appreciated by those in charge of similar furnaces not so fitted.



THE "EMPIRE" OIL-FIRED ROLLING METAL MELTING FURNACE: BY MESSRS. ALLDAYS & ONIONS, LIMITED.

The furnace is fitted with Alldays' patent oil burner. It is claimed that this is the only burner with which perfect combustion can be obtained; consequently a maximum of heat is ensured from the oil burned, the air pressure necessary varying from 5 inches W.G. to 2 to 3 lbs. per square inch, according to the class of work and the size of the burner. Dry steam can also be used for atomising the oil, air being induced by other means; but this method will not give so hot a fire as air under pressure only; further, it would be advisable to use a steam separator near the burner to remove condensation.

The proper proportion of air and oil is under complete control, being adjustable at the nozzle; hence, when once adjusted, no alteration of pressure takes place as is the case when the adjustment is done by means of cocks on the main pipes leading to the furnace. A needle valve controls the oil and a cone valve the air supply; each is fitted with a locking ring, so that when several burners are in use on a furnace it is possible to lock the valve on each of them, thus ensuring the same amount of fuel passing through each burner. The needle valve is provided with a packing gland to prevent leaking of the oil.

Practically any form of oil may be used in the furnace—creosote, crude oil, petroleum, etc. The oil consumption is approximately two gallons of oil to melt

100 lbs. of brass, though the consumption is of course largely dependent upon the quality of the oil used and the manner in which the furnace is handled. The melting of turnings and borings would naturally take longer than ordinary scrap. It is claimed that any mixture may be melted without fear of contamination, as the furnace is easily cleaned. When the furnace is required for melting aluminium only, a thinner lining may be employed, thus giving a much larger capacity to the furnace. For example, the No. 3 size for general purposes would have a melting capacity for aluminium of about 150 lbs., but if designed for melting that metal only the capacity would be increased to 300 lbs.

The furnace is built in four sizes, with melting capacities varying from 100 lbs. of brass or 90 lbs. of cast iron in the smallest size, up to 1,420 lbs. of brass or 1,200 lbs. of cast iron in the largest size. The approximate time per melt is in the first instance 30 minutes, and in the last-named from 80 to 90 minutes. The required floor space is 54 inches by 44 inches and 83 inches by 60 inches, respectively.

Positive Pressure Blowers.

The design and construction of the positive pressure blower illustrated is a radical departure from the form of most blowers. The blower has but one impeller, and this feature overcomes a common trouble with two-impeller blowers, that is, the transmission of power through the gears connecting the rotating parts which causes the gears to wear and the impellers to strike each other on account of the "backlash." It also overcomes the friction, wear,

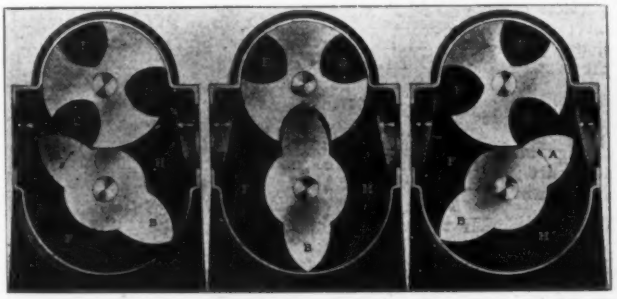


FIG. 1. FIG. 2. FIG. 3.

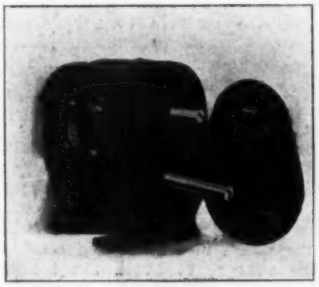


FIG.

weight and pulsation common to the "vane" or "paddle wheel" type of blowers which employ the use of sliding and rubbing parts for the work of compression.

There are two rotors, one, the impeller, having two projections or heads, the other, the idler, having three recesses into which the impeller heads mesh. The rotors fit respectively in the twin parallel bores of the cylinder or case. The inlet port is to the right, the discharge port to the left. The cylinder heads contain the bearings and are secured at either end of the cylinder. Gearing controls the rotors so that the impeller makes three revolutions while the idler makes two, the heads on the impeller meshing with the recesses in the idler to prevent the escape of air to the inlet.

The operation of the blower is illustrated in Figs. 1 to 3. Starting with Fig. 1, the impeller head A, moving in the direction indicated by the arrows, has begun the expulsion of air from the idler recess C, while head B is driving the air contained in the space F into the discharge port with its forward side, and filling the space H with its rear side. In Fig. 2 the head A has completed its cycle and expelled the air in recess C into the discharge port, while head B continues to drive the air from space F to the discharge port, and also to increase the space H with its rear side. In Fig 3 the head A has left the idler recess C and is beginning with its forward side, the compression of a fresh charge of air in space H, head B at the same time continuing to drive the air in space F into the discharge port with its forward side. Continuing the movement, head A will soon reach the position shown in Fig. 1, having made a complete revolution which, rapidly alternating with head B, produces a constant flow of air from the discharge port, free from pulsation.

The greatest advantage lies in the fact that the gearing between the two rotors is not called upon to transmit any appreciable power. It is evident from the diagrams that the idler performs no work in the compression of the air, and hence consumes no power other than that necessary to rotate it upon its bearings and keep it in unison with the impeller. Both sides of the recesses in the idler are of exactly similar area, so no air pressure, however great, would tend to interfere with the rotation of the idler as the pressure would always be balanced. There is no internal contact and consequently no friction or wear between the rotors or between the rotors and the cylinder, all of which are separated by a slight clearance; and as only one rotor, the impeller, is used in the compression of the air this relationship is safely maintained.

The makers of this blower are the W. S. Rockwell Company, New York.

Coke for Foundry Purposes.*

All coke is made by heating coal until the volatile matters are expelled. The volatile matters consist of substances produced mainly by the decomposition of the coal by heat, and containing the gaseous elements, hydrogen and oxygen, in combination with carbon and with each other. Some of these vaporised compounds are condensed when the gases are cooled, and constitute the tar which is recovered. Others remain as gases, and when suitably purified constitute ordinary coal gas. The residue left is coke.

Products of Coking.

(1) Coke, consisting of the fixed carbon, *i.e.*, carbon not removed in the volatile matters, and the inorganic matter (ash) of the coal. Only a very small portion of the gaseous elements remains.

(2) Tar, consisting of various liquid and solid hydrocarbons and other substances which the fluid substances retain in solution, together with free carbon.

(3) Gas, consisting of hydrogen and hydrocarbons of a non-condensible character. Of these marsh gas and olefiant gas are the principal.

The character of the coke and the composition of the volatile matters depend on the nature of the coal, and the manner, rapidity, and intensity of heating. In all cases, save for gas making, the coking is carried on by burning the whole or a portion of the volatile matters to supply the heat necessary. Only caking coals produce satisfactory coke, and the method of heating is determined by the process by which the coke is made.

Foundry Coke.

Coke for foundry purposes should be (1) strong and hard; (2) dense; (3) should have good cell structure; (4) be as free as possible from ash; (5) should contain little sulphur, (6) should be uniform in texture.

Hardness and Strength.—This is necessary to resist disintegration in transit and crushing by the weight of the charge, to avoid the blowing away of coke and the production of small particles which by admixture with the slags produce pastiness or infusibility, and may shorten the length of the blow by eventually choking the furnace, causing the charge to "hang." Breaking of the coke into small pieces owing to weakness also increases the amount of surface over which burning is going on; and the fuel may burn to waste if the heat cannot be utilised as fast as produced.

Density.—This may refer to the carbonaceous matter and also to the coke as a whole. The density of the carbonaceous matter determines the ease with which the coke ignites and the freedom with which it burns. Soft forms of carbon ignite and burn readily; denser forms like graphite only with difficulty. The denser and more graphitic the coke, the less readily it ignites and burns. It will consequently determine the strength of blast that can be employed. Softer coke loses strength at high temperatures when burning and is more liable to crush and interfere with the working of the furnace. The denser the carbon the higher the blast pressure that can be employed. Soft coke is not suitable for high pressure blast. On the other hand, the densest carbon is not suitable for a soft blast, as under those conditions it does not burn with sufficient freedom. The surface is not scavenged of the products of combustion. Hence in this respect the coke used must be suitable for the blast pressure and volume. Density of the mass determines the concentration of heat possible.

Furnace operations are dependent on the heat generated in two ways:—(1) To attain a certain necessary temperature; (2) to provide the heat utilised in melting the metal and slag and that lost by radiation and in the escaping gases.

In every case a certain minimum quantity of heat is required for these purposes, and this is provided by the coke burnt, which depends upon the amount of air blown in. The efficiency with which the heat is utilised, that is, the minimum fuel required to do a certain amount of work, depends largely on the concentration of the heat. The narrower the space the less are the losses arising from radiation and in the gases passing from the furnace, as the latter are more effectively cooled by contact with the cold material in the upper part of the cupola.

It must be also remembered that the heat is more directly applied to melting purposes. The substances in the furnace become heated by—(1) contact with hot solids; (2) contact with hot gases; (") absorption of radiant heat from the incandescent coke to which they are exposed.

Increased temperature arising from concentration of heat helps in all cases, and thus increases efficiency. There is a certain quantity of heat necessary to heat and melt the iron at the lowest temperature at which it can become fluid. A larger amount raises the temperature of the metal and slag and increases their fluidity. It follows that the same amount of fuel burnt with greater concentration will produce more fluid and hotter metal.

The density of the coke affects this as follows: If two samples of the same weight, one of which is denser than the other, burn at the same rate, the quantity of heat developed in a given time will be the same, but will, in the case of the denser fuel, be concentrated on a smaller surface exposed. It is thus that the densest coke yields the highest local temperature by providing sufficient material to utilise the whole of the air blown in as blast, in a smaller compass. With a less dense coke the burning, and thus the heat developed, is more diffused, the melting zone rises further above the tuyeres, and the local heat is less intense. More coke will be necessary to produce iron as hot as is produced by the denser coke, and the output of the furnace will be diminished. It is quite possible to have coke too dense to burn freely with a light blast and to have cool metal with an accumulation of unburnt coke in the furnace with the prolongation of periods of waiting for metal. Where few tuyeres are used and the coke is very dense, it is an advantage to have the tuyeres set more or less tangentially so as to detain the air in the combustion zone for a slightly longer period by retarding the ease with which it rises in the cupola.

Soft coke burns freely but gives little concentration of heat, and will tend to produce "dull" metal at a lower temperature. Dense coke gives hot metal and rapid melting. The density is largely dependent on the method of manufacture. It depends on the mount of fixed carbon left by a given weight or volume of coal. That process which leaves the

* Paper read before the Lancashire Branch of the British Foundrymen's Association by Mr. E. L. Rhead, F.I.C., F.C.S.

greatest weight, if unaccompanied by swelling of the mass, will give the densest coke.

Cell Structure.—If the surface of the coke were quite smooth the burning would be confined to the surface of the pieces of coke. The cellular structure increases the surface to which the air has access, thus increasing the rapidity of combustion in a mass of given size, so that coke consisting of denser carbon but with a good cell structure would permit of rapid combustion. The density of the carbon would not interfere with the freedom of burning and the rapid development of heat. The structure determines the distance to which the air at given pressure can penetrate and cause combustion of the coke. The pits detain the products of combustion and ensure better abstraction of heat from them, resulting in more rapid heating up of the coke and tending to localise the heat in the melting zone. The structure also influences the best volume and pressure of blast. The greatest localisation is obtained when the pressure of air is just sufficient to sweep away the greatest amount of products of combustion that can be produced in a given time.

Cell structure is chiefly affected by the nature of the coal, the condition in which it is introduced into the oven, uniform heating, the temperature of coking, and the rapidity with which it is attained. With coals that become very soft when heated better results are attained by more gradual accession of heat to avoid swelling and allow escape of the volatiles.

Uniformity.—Coke burns most rapidly when the air has most easy access. If a piece of coke burns more rapidly in one place than in another there is a tendency to burn into pieces. Very irregular coke will give a multitude of small pieces which prove as troublesome as crushed coke. This is one reason why coke that appears strong and satisfactory in the cold behaves so unsatisfactorily on burning. The soft open places to which the air has access burn out and the mass goes to pieces. It will not stand a strong blast.

For the same reason the crushing strength in the cold may be misleading. An open and irregular coke consisting of high density graphitic carbon may resist pressure to an extent equal to the resistance of a closer coke made up of carbon of lower density. On burning at low temperatures or under natural draft without pressure from heavy materials—as in a wind furnace—it may burn rapidly and develop a high temperature and prove equally or more satisfactory, the greater ease with which the air finds access to the coke being a distinct advantage. The denser coke, though of somewhat less dense material, would under blast behave more satisfactorily.

Cracks and fissures existing in the coke form channels and admit the air when burning. Often these cracks are coated on the sides with deposited graphite. Immediately behind this the coke is soft and black. The crack forms a main channel by which the volatiles escape from the coal. This appearance is more often met with in by-product coke than in beehive coke. The soft black portions burn much more readily than the hard face.

It is extremely difficult to adjust the blast to suit coke that is not uniform. The consumption will be increased and the metal will not be as hot as with uniform harder coke. It not infrequently leads to scaffolding and hanging of the furnace, especially with an excess of blast. The soft portions may burn away higher up the furnace or too rapidly. In the one case the metal has not become sufficiently hot to be melted by the heat generated, in the other it has not time to absorb the heat unless excessive fuel be used. As a consequence the fuel left in the melting zone is insufficient, the heat is not properly distributed through the charge, the gases carrying and distributing the heat find their way through the easiest passages, and the regular melting down is interfered with.

In the manufacture of coke coal slack is used. This is often ground to powder before coking to make the coke more uniform in texture.

Freedom from Ash.—Ash in coke makes it poorer by taking the place of combustible matter, and requires fluxing, for which limestone or other flux must be used. More ash in the coke means a greater amount of slag, to melt which more coke must be burnt to furnish the heat necessary for that purpose. All these occupy space in the furnace and reduce the output. In addition the tendency of the charge to hang is increased, also the wear and tear on the lining, and there is greater tendency to produce "dirty" metal and limit the length of run.

The ash is produced from the earthy or other inorganic matters contained in the coal. These vary greatly in amount. They consist of iron pyrites, earthy and stony matters occurring as "dirt partings" in the coal and pieces of the shale and other rocks in which the coal occurs. Iron pyrites is disulphide of iron, and is very heavy. It contains 54 per cent. of sulphur. Half the sulphur it contains is expelled when the coal is coked. The stony matters are very much of the nature of clay, but carbonate of lime and other substances are often present. These are much heavier than pure coal. The composition of the ash varies as follows:—

Approximate Analysis of Ash.

	per cent.
Silica	30 to 60
Alumina and Ferric Oxide	35 „ 55
Lime	5 „ 10
Magnesia	0 „ 2
Sulphuric Acid	3 „ 8
Phosphoric	0·5 „ 7·5
Potash and Soda	2 „ 4

Much of the foreign matter can be separated by washing the coal before coking. This is now often done. Since the coke produced is only equal to 60 to 75 per cent. of the coal coked, and none of the ash is removed in coking the coke produces a larger percentage of ash than the coal. Thus a coal yielding 10 per cent. of ash and only yielding 60 per cent. of its weight of coke would produce coke containing 16 per cent. of ash. If it yielded 75 per cent. of coke the ash in it would only be 13·2 per cent. It is on this account that the percentage of ash in by-product coke (always greater in amount than when beehive ovens are used) is less than the ash in beehive coke made from the same coal.

Sulphur.—Coke giving a red ash is more likely to contain a larger amount of sulphur. The red colour is due to oxide of iron (ferric oxide) produced by burning off the sulphur from sulphide of iron and converting the iron into oxide. Coke giving a whiter ash is merely likely to contain little sulphur, although in coke giving a white ash that element might occur as sulphate of lime or alumina. Sulphur is too often made the scapegoat for every irregularity occurring in castings, and much of the blame is thrown on the coke. Although the defects are often due to other causes, it is important that the coke should be as free as possible from sulphur to prevent contamination of the iron. If iron during melting comes in contact with iron sulphide it will in most cases dissolve and take it up. Other sulphides present in the ash may be decomposed and the sulphur taken up by the iron. Such an introduction is very injurious, and under the conditions of working of an ordinary cupola is very difficult to prevent. The only perfect

safeguard is to use coke as free as possible from sulphur in any form. The conditions favouring the passage of the sulphur present in the coke into the slag is to produce an easily fused slag that will run freely. Sufficient lime must be used to effect this. The use of fluor-spar (Bohemian flux) also assists in producing fluidity, and in the removal of sulphur to the slag. It presents the lime in a suitable form to attack sulphide of iron. Thick viscous slags of a cindery nature from whatever cause favour the passage of sulphur into the metal.

A high melting temperature ensures greater fluidity of slag, and better and quicker separation from the metal, and thus reduces the amount of sulphur taken up. Hence better coke, richer in carbon, even though as much sulphur may be present as in an inferior kind, will do less harm to the metal. For the same reason increased temperature resulting from the use of a larger coke charge favours the exclusion of sulphur, and phosphoric pig-irons of lower melting point and greater fluidity are less affected than those with higher melting points. Similarly, more sluggishly working of the furnace from any cause will tend to the introduction of more sulphur. Irons with high silicon and manganese contents are less affected than those containing a smaller amount.

It will thus be seen that high carbon coke with little ash and low sulphur with suitable physical characters to enable rapid and complete burning in the smaller space will ensure the best results from the cupola in the rapid melting of clean, hot metal with the least possible fuel consumption.

In conclusion, attention should be drawn to the desirability of keeping coke under cover so protected that it shall be kept dry. Water introduced into the cupola in this way causes a waste of heat. If the cupola is correctly designed, and the air supply is properly managed and distributed the coke cannot be too dry.

The National Physical Laboratory.

The annual report of the National Physical Laboratory for the past year has been issued, and contains an exhaustive account of the work carried out during 1909, and the work proposed for the current year. In the Department of Metallurgy and Metallurgical Chemistry the earlier part of last year was occupied by the completion of the "Ninth Report to the Alloys Research Committee on the Properties of Some Alloys of Copper, Aluminium and Manganese," by Dr. Rosenhain and Mr. Lantsberry, particulars of which we published in our issue of February last. The work of the eutectics research has been directed principally to the elucidation of the manner in which eutectic alloys undergo solidification. The work of the research on temperature density curves has been continued, but no final results have yet been obtained. The fact that the results referred to in the previous report were vitiated by the formation of internal cavities in the metal has been verified, and systematic experiments have been made with vessels of various shapes in order to ascertain the form of containing vessel in which there is least tendency to the formation of such "blow hole." The systematic study of the modes of fracture of steel has been commenced by an examination of the various types of fracture of a series of steels previously used by Dr. Stanton and Mr. Bairstow for experiments on impact testing. Metallurgical test work, consisting principally of the investigation of engineering breakages or other failures has again shown a gratifying increase, and a considerable number of interesting and important cases of this kind have been investigated.

During the current year it is proposed to continue the work outlined in the scheme of work contained in the report for 1908 and to carry on the various researches in progress in the department. These include principally:—Alloys research for the Alloys Research Committee, eutectics research, temperature-density curves, systematic study of the modes of fracture of steel, and the effects of strain on metals at high temperatures.

Publications Received.

Registration of Firms Bill.

By Walter Bean. London: Walter Bean, 174, Aldersgate Street, E.C.

This is a pamphlet of 82 pages, containing a lecture delivered to the members of the City of London Tradesmen's Club, on Lady Day, 1909, by Walter Bean, the text of Lord Brassey's Bill, Press comments and correspondence, and various essays, etc. The author of the lecture deplores the apathy of tradesmen generally to the Bill, which stipulates among other things that (*a*) every firm carrying on business at any place in the United Kingdom under a trade name which does not consist of the full names of all the partners without any addition, (*b*) every person carrying on business under any trade name consisting of or containing any name or addition other than the full name of that person, shall register the name under which the business is carried on. Registration, it is stipulated, shall be effected by notifying the following particulars: (*a*) the trade name; (*b*) the general nature of the business; (*c*) the place or places of the business; (*d*) the full name, usual residence, and other occupation (if any) of the person or persons carrying on, or intending to carry on, the business; (*e*) if the business is commenced, or any new place of business is established, the date of the commencement of the business or establishment of the place of business; where a firm or person carries on business under two or more trade names, each of those trade names must be registered; where a firm carries on business in the United Kingdom and also abroad, the name of any foreign partner must be included in the statement, whether he is a British subject or not. There is no doubt that the provisions of the Bill are of importance to traders generally, for the registration of firms has been strongly advocated by Chambers of Commerce for some time. But until the matter receives more general and enthusiastic support it is difficult to get the Bill through Parliament. Since its introduction originally by the late Sir John Barran, M.P., it has been brought in annually down to the time of the late baronet's death, and has been continually rejected. But there is still an influential backing to the proposal contained therein, and when public interest has been more fully aroused to the importance of the subject it will probably receive more effective consideration.

Catalogues.

ALLDAYS & ONIONS PNEUMATIC ENGINEERING COMPANY, LIMITED, Birmingham.—Pamphlets and sheet catalogues relating to "duplex" blowing fans, ovens and forge furnaces, forging hammers, etc.

Inventions.

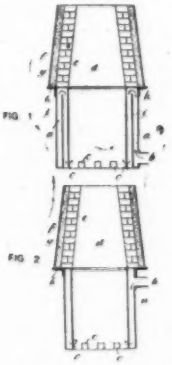
Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

4,277.*Machine for making moulding beams for cast chains. A. Schurhoff, 22, Gray's Inn Road, London.
5,266.*Electrical induction furnaces. (Poldihütte Tiegelguszsthalfabrik, Austria.)
5,267.*Smelting-furnaces. (Poldihütte Tiegelguszstahlfabrik, Austria.)
5,709.*Crucible furnaces. R. Eickworth.
5,879 Furnaces for annealing metal. H. E. Harris and M. Briscoe.
6,035.*Charging electric resistance furnaces. A. Petersson.
6,036. Furnaces for metallurgical purposes. (Rudolph Oswald Ahlers, Portugal.)
6,157. Machines for testing the cutting power of files. W. Ripper, 15, St. James Row, Sheffield.

Abstracts of British Patent Specifications recently accepted.

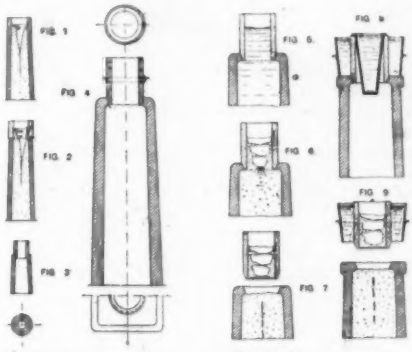
20,202 (1901). *Furnace for the Melting of Metals.* E. Bosshardt, 4, Eifel Platz, Cologne, Germany.—This invention relates to improvements in connection with furnaces for melting wrought iron or other metal ingots which are placed in crucibles and carried within the furnace in which live fuel is employed, and in which a blast of air is used for inducing the necessary current. The invention consists in introducing the air blast into a chamber formed by the hollow walls of the ash pit beneath the furnace grate, and causing it to traverse the same before entering the ash pit on its way to the



Bosshardt's Furnace for Melting Metals.

furnace, thus effecting a pre-heating of the air by means of heat which would otherwise be lost, the inlets for the pre-heated air being so arranged as to uniformly distribute the air below the grate. The pre-heating chambers are provided with intermediate walls, whereby a more efficient pre-heating may be effected, and loss of heat by radiation or conduction from the furnace walls is prevented by providing the same with an insulating layer of non-conducting material between the fire-brick lining and sheet metal exterior. Fig. 1 is a sectional elevation of a furnace adapted for the melting of wrought iron and capable of dealing with a considerable number of crucibles; Fig. 2 shows in sectional elevation a simpler form of furnace.

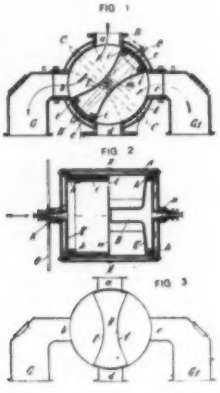
28,260. (1908). *Process and Means for Casting Steel Ingots.*—N. Kostileff, Nischne-Saldinskij Sawod, Government of Perm, Russia. Fig. 1 is a vertical longitudinal section of an ingot mould containing a steel ingot cast in the ordinary way, showing an injurious cavity. Fig. 2 is a similar view, showing a clay top, in which the extension of the cavity from the waste head into the ingot proper is very apparent. The present invention provides an improved construction of the ingot mould so far as it relates to the junction of the mould with the clay top. The contacting surfaces of the ingot mould and the clay top, instead of being horizontal as hitherto, are arranged at an angle, in fact, almost vertical; that is to say, the lower part of the clay top is bevelled to a more or less sharp angle, and the edges of the aperture in the top of the ingot mould are bevelled to correspond so that the clay top will fit tight therein in such a manner that the lower edge of the clay top will project more or less inside the ingot mould, and thus come in contact with the molten metal contained in the latter. Fig. 3 illustrates a cylindrical ingot mould having a clay top fitted in it; Fig. 4 illustrates the combination of a cylindrical clay top with an ingot mould of rectangular shape. As shown in the figure, the ingot mould is contracted at the top to form a



Process and Means for Casting Steel Ingots.

conical aperture to receive the clay top, which is fitted therein tightly, with its lower edge contacting the inner edges. The clay tops may be used cold, or they may be heated before use. When the clay top is to be used cold, a ring is preferably slipped over the clay top (Fig. 4), and wedged tight thereon. This ring is intended to prevent the clay top from bursting when it is filled with molten metal. The molten metal filling the ingot mould and the clay top up to near the upper edge of the latter, in cooling, shrinks at first uniformly almost without adhering to the sides of the clay top (Fig. 5). Then a crust forms at the sides with cavities in the centre of the clay top (Fig. 6). Sometimes a crust forms on the top, which may be broken to enable the settling of the metal to be observed. When the level of the steel, which has now become viscous, has sunk to the lower edge of the clay top, the clay top is removed from the mould, leaving some still fluid metal on the top of the ingot. The top of the ingot is then immediately drenched with cold water for the purpose of causing a crust to form on the top of the ingot. The formation of the crust may also be promoted by pouring cold water into the clay top before the removal of the latter from the ingot. This feature is of great importance, and by this means the ingot remaining in the mould has a flat upper surface (Fig. 7). After the metal has been poured into the first set of previously heated ingot moulds, the residual slag is poured into inner cast-iron receptacles inserted in the clay tops, and also into outer cast-iron receptacles formed by the outer jackets of the clay tops (Fig. 8) of the second set of ingot moulds.

3,609 (1909). *Change-over Device for the Gas and Air Flues of Siemens-Martin or other Regenerative Furnaces.* Gustav von Bechen, Josefstrasse, No. 6, Kalk, near Cologne, Germany.—The device is of the well-known type comprising a cylindrical casing provided with four unions, and with a change-over valve revoluble about the axis of the cylinder. The invention consists in the change-over valve being in the form of a hollow body or valve proper, provided with hollow end discs, the edges of which fit tightly against the internal surface of the cylindrical casing, and through which discs and body cooling water can be passed for the purpose of preventing the valve from



Change-over Device for the Gas and Air Flues of Siemens-Martin or other Regenerative Furnaces.

sticking fast through becoming too hot. The longitudinal faces of the hollow body which make contact with the internal surface of the cylindrical casing are of a width greater than that of the openings into the casing of the gas inlet port and the port leading to the smoke flue, so that during the reversing operation gas cannot escape directly to the chimney through the valve casing. Figure 1 is a transverse cross-section of the device on the line A—A of Figure 2; Figure 2 is a longitudinal section, the left half being on the line B—B of Figure 1, and the right half being on the line C—C of Figure 1; and Figure 3 is a diagrammatic transverse section similar to that shown in Figure 1, the valve however being represented in another position.

23,958 (1908). *Process of Cementation of Iron, Soft Steel, Cast Steel, etc.* E. Jouard, 149, Boulevard Victor Hugo, St. Ouen, France.—The main feature of the invention is a cementation in proportion to any degree or hardening which it is desired to obtain. This result is obtained by means of a mixture the composition of which is as follows:—Ferrocyanide of potassium, 25 parts; bichromate of potassium, 10 parts; ammonium-chlorate, 5 parts; chimney-soot, 30 parts; horn-powder, 30 parts. The whole mixture must be pulverised to a very high degree. The pieces to be hardened are put into a casing of known construction and bedded into a suitable quantity of powder of the before-mentioned composition so as to ensure the desired degree of hardening being attained. A constant temperature of about 850 degrees C. must be kept on during the process of cementation. By way of example, a file is surrounded with the powder so as to have a layer of about 5 m.m. thickness in any casing as ordinarily used for such purposes, and is then heated for one hour at the aforesaid temperature. A very hard skin of about one m.m. thickness will thus be produced which can be further increased by about 1 m.m. thickness for every hour of heating until finally the entire body has been transformed into hard steel.

Trade Talk.

THE capital of James Cartland & Sons, Limited, brassfounders, of Birmingham, has been reduced from £200,000 to £169,700.

MESSRS. WOOD, STANNARD & HENDRA have acquired the business of Messrs. H. Baldwin & Company, iron and brassfounders, Burnham, Bucks.

MESSRS. THOMAS SHANKS & COMPANY are making further extensions to their pattern shop, in the block of buildings which were only erected last year.

WM. BEARDMORE & COMPANY, LIMITED, have decided upon the extension of their naval construction works at Dalmuir, so as to include gun mounting on a large scale.

MESSRS. W. H. SALMON and J. SALMON, engineers, Northfleet, Kent, trading under the style of The Salmon Anti-Friction Metal Company, have dissolved partnership.

MESSRS. S. W. CLOUGH and S. Hardwick, gas, oil, and general engineers, Windhill, Yorks., trading under the style of S. W. Clough & Company, have dissolved partnership.

MESSRS. J. C. BUSBY and A. E. Elmes, Baron Street, Pentonville, London, N., engineers, who traded under the style of E. Busby & Company, notify a dissolution of partnership.

AN accident to the flywheel, resulting in the death of one man and injury to several others, occurred recently at the foundry of Ruston, Proctor & Company, Limited, Lincoln.

A DISSOLUTION of partnership is notified in connection with Messrs. J. F. Charleton and M. Allen, ironfounders, South Shields, who traded under the style of Charleton, Allen & Company.

THE shareholders of the New Lowca Engineering Company, Limited, have decided to wind the company up voluntarily, with Mr. R. F. Miller, of Barrow-in-Furness, as liquidator.

THE business of Thomas Noakes & Sons, Limited, engineers and boiler fittings manufacturers, Osborn Place, Whitechapel, London, E., is being offered for sale by tender until April 4.

PROFESSOR S. M. DIXON lectured last month at the Municipal Technical School, Birmingham, to the members of the Birmingham Metallurgical Society on "Mechanical Tests for Steel."

MESSRS. S. PEACE & SONS, Wellmeadow Steel Works, Sheffield, have acquired the business of Messrs. F. L. Hansell & Company, steel manufacturers, etc., Hansell Canal Works, Eyre Lane, Sheffield.

MESSRS. PARSONS & COMPANY, Foxoak Tube and Engineering Works, Cradley Heath, have acquired the business lately carried on by the Atlas Tube and Fittings Company, Limited, Cradley Heath.

WE are officially informed that the rumour that John Lysaght, Limited, of the Oak Iron Works, Newport, Mon., purpose erecting large works at Woolastone, Forest of Dean, is entirely without foundation.

A DISSOLUTION of partnership has been notified in connection with Messrs. W. L. Clouston and A. Clouston, engineers, etc., North Shields, Northumberland, who traded under the style of John Thomas Clouston.

THE BIRMINGHAM METAL AND MUNITIONS COMPANY, LIMITED, Adderley Park Rolling Mills, Birmingham, have opened London offices at Kingsway House, Kingsway, W.C., which will be in charge of Mr. C. G. Clarke.

THE shareholders of the Eclipse Tool Company, Limited, Linwood, near Paisley, have decided to wind up the company voluntarily. Mr. W. McLaren Stevenson, 37, High Street, Johnstone, has been appointed liquidator.

THE works at Wishaw, belonging to the Inshaw Seamless Iron and Steel Tubes, Limited, now in liqui-

dation, have been taken over by the Coltness Iron Company, Limited, who expect to make a fresh start in the course of a few months.

COCHRANE & COMPANY, LIMITED, Ormesby Iron Works, Middlesbrough, have taken an order for the Glasgow Corporation Water Works Department for rather over 5,000 tons of 36-in. diameter socket and spigot pipes, valued at approximately £30,000.

AT a recent meeting of the members of the South Staffordshire Iron and Steel Institute, held at Dudley, Mr. F. J. Cook, president of the British Foundrymen's Association, read a paper on "The Physical Properties of Cast-iron." Mr. J. W. Roberts presided.

THE firm of James Henry & Company, brassfounders, 9, Shuttle Street, Glasgow, of which Mr. James Black Henry and Mr. John Henry were the sole partners, has been dissolved by the retirement of the latter. The business will be carried on by the former under the same firm name.

THE ANDERSON FOUNDRY COMPANY, LIMITED, are supplying points and crossings to the Bengal-Nagpur Railway, William Beardmore & Company, Limited, are supplying 124 pairs of wheels and axles to the same concern, while Cammell, Laird & Company, Limited, have an order for 250 steel tyres.

THE partnership hitherto existing between Mr. H. Tinsley and Mr. A. Snell having been dissolved, the former gentleman is continuing his business at Stanley House, Eldon Park, South Norwood, S.E., and will trade as H. Tinsley & Company. Considerable extensions are being made to the works and laboratory equipment.

THE BRITISH MANNESMANN TUBE COMPANY, LIMITED, Landore, S.O., South Wales, have decided to instal a drag link conveyor at their works for conveying steel bars between the sizes of 3 in. diameter by 14 in. long and 8 in. diameter by 3 ft. 6 in. long. The order has been placed with Ed. Bennis & Company, Limited, of Little Hulton, Bolton.

MESSRS. H. J. SKELTON & COMPANY, Royal London House, Finsbury Square, London, E.C., have secured from the Thames Iron Works Shipbuilding and Engineering Company, Limited, the contract for practically the whole of the iron and steel material required by them for the construction of the "Dreadnought" they are building for the Admiralty.

PROFESSOR T. TURNER delivered a lecture before the members of the Metallurgical Society and the University of Birmingham Metallurgical Society, recently, on the "Temperature and Volume Changes in Metals." Mr. Rosenhaw's lecture on "Some Recent Advances in the Metallography of Steel" had to be postponed in consequence of the author's indisposition.

THE Toronto City Council has awarded a contract for a quantity of iron pipes to a local firm, whose price was 270 dollars higher than the tender made by D. Y. Stewart & Company, Limited, of Glasgow. Mr. Grigg, British Trade Commissioner in Canada, has written to the civic authorities that if such practice is followed, British manufacturers will cease tendering for Canadian trade.

A. F. CRAIG & COMPANY, LIMITED, Caledonian Engine Works, Paisley, are extending their foundry by the addition of a bay, which will practically double their present floor space. The shell of the building is complete, and the two main cranes—by Applebys, Limited—are in position on the runways. These will be electrically operated, and each has a lifting capacity of 37 tons.

SIR CHRISTOPHER FURNESS, M.P., informs us that, so far as he is concerned, there is no truth in the statement that a scheme is on foot for establishing armour-plate works at Cargo Fleet, near Middlesbrough. Sir Charles McLaren, chairman of Palmer's Shipbuilding and Iron Company, Limited, states that the subject has never been suggested, and he gives an unqualified denial to the statement.

A NEW limited liability company is being formed at Motherwell to carry on business under the style of the Glencairn Iron & Steel Works. Ten acres of ground have been secured in the Flemington district, and it is expected that the turf will be cut within the next few weeks. Two mills and a ball furnace will probably be put down, and the rolling of all kinds of structural material will be undertaken. Mr. Hugh Reid will be the managing director.

THE SHELTON IRON & STEEL COMPANY, LIMITED, of Stoke-on-Trent, have just ordered from Messrs. Henry Pels & Company, Lincoln Chambers, 9, Portsmouth Street, Lincoln's Inn Fields, London, W.C., what we believe to be a record size of billet shears. The machine in question is to cut 15 in. by 2¼ in. slabs, as well as steel billets up to 5 in. square (cold), the material to be dealt with having a tensile strength of up to 55 tons per square inch.

THE 21st annual report and balance-sheet of the Scottish Central Ironmoulders' Association has just been issued. The membership of the Association, which was started with 253 on March 25, 1889, now numbers 4,647. The present membership also shows an increase of 176 over last year. The funds at present stand at £31,049 12s. 11½d., as against £33,423 12s. 7d. at the end of last year, which amounts to fully £6 13s. per member.

MAWDSLEY'S, LIMITED, Zone Works, Dursley, Glos., have appointed Mr. G. H. Lowe, of Warrington, to represent them in the Manchester district, comprising Lancashire, North Wales, Derbyshire, the Potteries, and South Yorkshire. Owing to Mr. C. E. Lugard, the company's late representative on the North-Eastern Coast, having left the district, Messrs. George Cragge & Company, of Albert Buildings, Middlesbrough, now represent them.

THE High Commissioner for Canada is advised by the Department of Customs at Ottawa that an Order in Council was approved on February 15 last, providing that on and after Tuesday the first day of March, 1910, the surtax imposed in 1903 upon articles which are the growth, produce, or manufacture of Germany, when imported into Canada, be suspended, in consequence of which the articles will in future be subject to the duties of the General Tariff.

A NUMBER of the members of the Birmingham Metallurgical Society visited Sheffield recently, and spent an enjoyable day visiting two of the large steel works. On their arrival they were met by a representative of Messrs. Sanderson Brothers & Newbould, and conveyed to the works of that firm at Brightside, where they spent a couple of hours viewing the high-speed cutting and drilling of cast-iron, and the hardening and tempering of swords and bayonets. Subsequently the works of John Brown & Company, Limited, were visited, where the Siemens furnaces and armour forges were closely inspected.

THE amount subscribed to the "Bennett H. Brough" Memorial Fund having proved insufficient for the endowment of a scholarship, the committee, after considering various other proposals, have decided that, with the funds at their disposal, the most suitable memorial would be an annual prize of books for the science side of the City of London School and a "Brough" medal, possibly supplemented by a prize of books, for mine surveying at the Royal School of Mines. These proposals have been submitted to and approved by the head master of the City of London School and the Governors of the Royal College of Science and Technology.

WITH a view of assisting the Engineering Standards Committee to meet the heavy expenses incurred in the preparation of its reports, it has been decided to make certain alterations in the Committee's price-list after March 31 next. The price of 21 of the reports will be raised, the prices of 28 will remain unaltered, and the price of one report, namely, that dealing with the British Standard Sections (Report No. 6), has been reduced with a view to it more readily finding its way into the hands of draughtsmen and others engaged in constructional work. Copies of the revised price-list can be obtained on application to the Secretary of the Engineering Standards Committee, 28, Victoria Street, Westminster, S.W.

In the House of Commons, recently, Mr. Buxton informed Mr. S. Roberts that the attention of the Board of Trade had been drawn to the effects upon the trade in high-grade steels and engineers' tools between Sheffield and France which would probably result from the new French tariff. The views of the Sheffield Chamber of Commerce had been brought to the notice of the French Government. The Tariff Bill as passed by that Chamber of Deputies, contained certain modifications of the original proposals, and these modifications were, on the whole, of a favourable character. The proposals still gave rise to apprehension in the minds of the Sheffield manufacturers. The Bill, however, had yet to be considered by the Senate.

The directors of the Talbot Continuous Steel Process, Limited, in their annual report, remark that during the year the South Durham Steel and Iron Company, Limited, started the plant for the Talbot Process which they have erected at their West Hartlepool works. As this plant, however, only started towards the end of the year royalty was only received in respect of the steel made for some two months. The large furnace which has been erected by the Skinningrove Iron Company is now being lined, and it is hoped that this furnace will be started during the spring of this year. There have been several Continental enquiries into the process, and the directors believe that serious business will result in the case of at least two large firms.

The production of pig-iron at the works of the Bengal Iron and Steel Company, Limited, during last year was 1,434 tons more than that during 1907-8. The output of the foundries shows an increase of 2,673 tons, compared with that of the previous year. The quantity of both sleepers and pipes produced during the year shows a substantial increase on the figures for 1907-8, but the demand for general castings again shows a falling off. The production of pig-iron and castings during the last four years is given in the following table:—

Year.		Pig Iron. Tons.		Castings. Tons.
1905—6	...	46,878	...	14,487
1906-7	...	39 246	...	12,564
1907—8	...	37,838	...	10,793
1908—9	...	39,292	...	13,466

The Vulcan Iron and Steel Company, Limited, has been formed, with a capital of £70,000 in £1 shares, to purchase the British letters patent and processes known as the "Bosshardt Casting Process," and to erect works for developing and working the same. The prospectus is accompanied by reports on tests of the process. There were offered for public subscription at par 50,000 shares, payable 2s. 6d. per share on application, 2s. 6d. on allotment, and 5s. on March 25, April 25, and May 25; of the remaining shares 10,000 are to be issued and credited as paid up and 10,000 are reserved for future issue, if and when required. The difference between the purchase price and the issued capital when paid up will provide the company with approximately £25,000 cash for working capital.

The amalgamation and incorporation of the Society of Engineers and the Civil and Mechanical Engineers' Society is now accomplished. The Society of Engineers was founded in 1854, and the Civil and Mechanical Engineers' Society in 1859, and, though originally they had slightly different objects in view, for some years past their work has been identical. The new Society has been incorporated under the Companies Act. This necessitated the drawing of a Memorandum and Articles of Association, as well as of new bye-laws, copies of which have now been issued, and contain many new features. According to the Articles of Association, the Society is to consist of four classes of members, as follows:—(*a*) Hon. Fellows; (*b*) Fellows; (*c*) Members; (*d*) Associate Members. The Society will also be entitled to elect Associates, who will not be members of the Society, although entitled to certain privileges. An entrance fee of two guineas and an annual subscription of two guineas shall be paid by Fellows and Members of the Society residing or being professionally engaged within a radius of 20 miles from the General Post Office, London.

Deaths.

Mr. C. Batting, of The Ironworks, Maidenhead, died recently, aged 59 years.

Mr. H. C. Siddens, iron merchant, Priory Street, Dudley, died recently, aged fifty-eight years.

The death is announced of Mr. R. Greenhalgh Melling, engineer, Radcliffe, at the age of seventy-eight.

The death took place recently of Mr. L. Cameron, steel manufacturer, Boston Works, Sheffield, aged 76 years.

Mr. T. Clark, of J. & T. Clark, Raglan Foundry, Bibson Street, Bradford, died recently, at the age of 73 years.

Mr. H. J. Rogers, who owned the Watford Engineering Works, Watford, died on the 9th ult., aged sixty-five years.

Mr. W. O. Plowright, of Plowright Brothers, Limited, engineers and ironfounders, Brampton, Chesterfield, died recently.

Mr. H. Pinnell, managing director of Whitehouse & Company, Limited, brassfounders, Brueton Street, Birmingham, died recently, aged 50 years.

Mr. James Hornsby, formerly head of R. Hornsby & Sons, Limited, engineers, Grantham, died unexpectedly on March 6, at his residence, Laxton Park, near Stamford, at the age of 75.

The death took place at Hove, Brighton, on March 7, of Mr. George Whale, late chief mechanical engineer of the London and North-Western Railway. Mr. Whale was born in 1842.

The death has occurred, at Ilkley, of Mr. J. Watson, secretary and director of W. Whitwell & Sons, Limited, Thornaby Iron Works. The deceased was 72 years of age, and had been connected with the works since their commencement.

The death is announced of Herr Emil Goecke, of Duisburg, in his 68th year. In the early seventies he occupied the position of manager of the Krupp Works (Johanneshütte), at Hochfeld, and from 1878 to his death was member of council of the Rheinische Stahlwerke, Meiderich.

Mr. Thomas Gray, the founder of the Clifton Ironworks, Coatbridge, has died at the age of 82 years. The deceased founded the ironworks about 50 years ago along with Mr. David Colville, and on the latter's removal to Motherwell the business in Coatbridge was carried on by Mr. Gray, associated with the late Mr. John Wylie.

Sir William Eames, Chief Inspector of Machinery for the Royal Navy, died on February 28 at his residence, 94, Tressillian Road, Brockley, London, S.E. He was the son of Mr. C. H. Eames, engineer, of Cork. Born in 1821, Sir William Eames became an assistant engineer in the Royal Navy in 1844, and a chief engineer three years later. In 1865 he was appointed to the post of assistant to the chief engineer of Chatham Dockyard, and in 1869 became principal engineer of the Dockyard, a position which he held until he retired in February, 1881. He became an Inspector of Machinery in May, 1870, and a Chief Inspector in August of the same year.

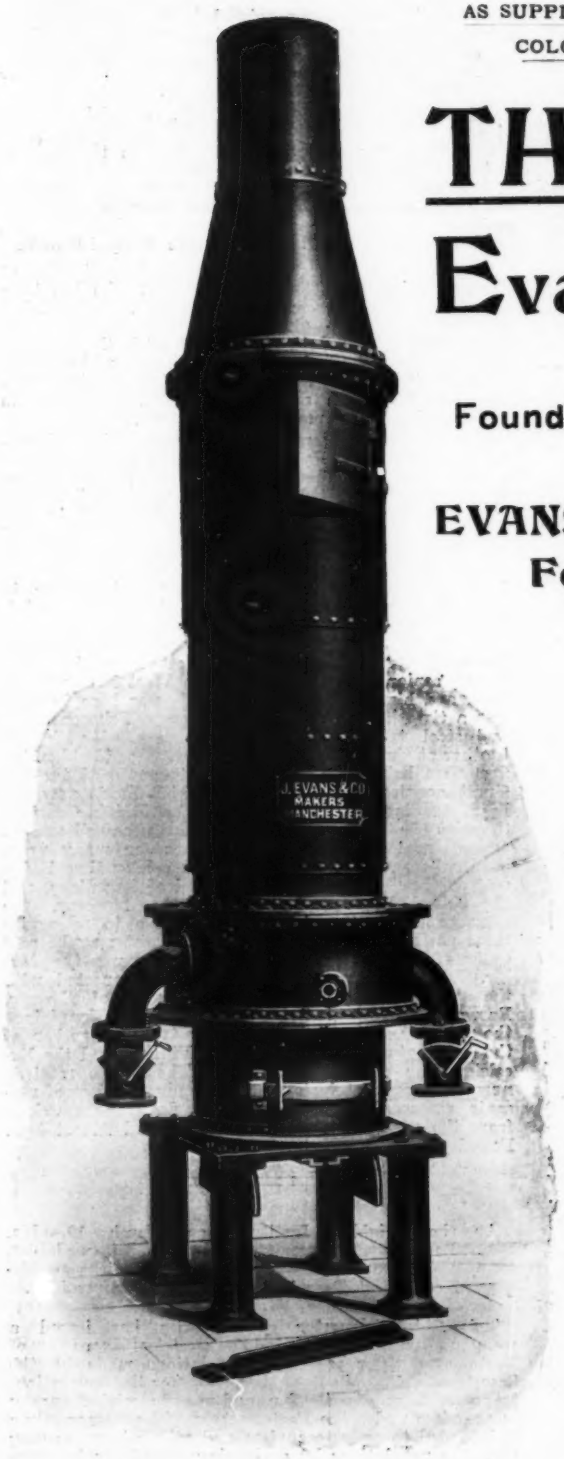
The death is announced of Sir Frederick Mappin, Bart., at Sheffield on March 19. The foundations of Sir Frederick Mappin's prosperous career were laid in 1835, when, at the age of 14, he left school in order to enter his father's business. His father had in that year terminated partnership in the firm of Arundel & Mappin, and started trading alone. Six years later Mr. Joseph Mappin died, and it thus came about that Frederick Thorpe Mappin, before he was 21, had to take over the management of the firm. He was eminently successful in the conduct of business. About three years later his younger brother joined him, the business being conducted by the brothers until 1859, when Frederick retired from the firm of Mappin Brothers, and became senior partner in the firm of Thomas Turton & Sons, Sheaf Works, Sheffield.

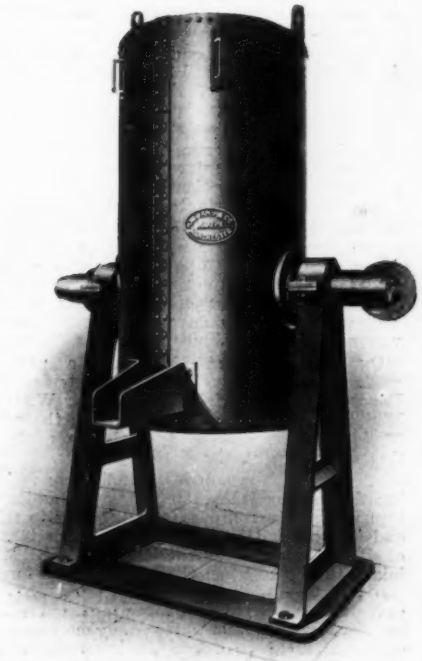
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE,
COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola.
Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.





James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

Personal.

THE gross value of the estate of the late Mr. T. Smith, of Rodley, Yorkshire, engineer and ironfounder, is £194,882.

THE late Mr. T. T. HARDY, a director of Michael Hunter & Son, Limited, Talbot Works, Savile Street, Sheffield, left estate valued at £23,598 gross.

MR. C. C. SCOTT, of Scott's Shipbuilding and Engineering Company Limited, Greenock, has been elected a director of the Leeds Forge Company, Limited.

MR. GEORGE HATTON, managing director of the Earl of Dudley's Round Oak Works, Limited, has been appointed a director of Lloyds' British Testing Company, Limited.

MR. C. J. STODDART, chairman and managing director of the Parkgate Iron and Steel Company, Limited, has been elected one of the vice-presidents of the Rotherham Chamber of Commerce.

THE late Mr. F. S. Bolton, J.P., one of the founders and a director of Thomas Bolton & Sons, Limited, copper smelters and wire drawers, Birmingham, left estate valued at £70,364 gross, with net personalty £51,565.

MR. W. THOMSON, B.Sc., at present a member of the technical staff at the yard of the London and Glasgow Shipbuilding and Engineering Company, Govan, has been appointed to the staff of Lloyd's Register.

THE late Mr. W. J. Cudworth, lately chief engineer to the Southern Division of the North-Eastern Railway, left estate of the gross value of £48,312 18s. 10d., of which the net personalty has been sworn at £22,769 16s. 7d.

MR. J. V. ELLIS, London representative of the Workington Iron and Steel Company, Limited, has been appointed manager of the combine. Mr. Ellis, who is only 35 years of age, is the son of Mr. Jos. Ellis, one of the managing directors of the company.

SIR WILLIAM MATHER, the head of the firm of Mather & Platt, Limited, engineers, Salford, has placed £10,000 in trust with a direction that the income arising therefrom shall be distributed annually among the firm's workpeople on the occasion of their annual holiday.

SIR ROBERT HADFIELD, chairman of Hadfield's Steel Foundry Company, Limited, who, a short time back had to leave this country for the benefit of his health, is now fully recovered. He is now at Colombo, and will start in a few days on his return to England by way of China and Japan.

ON March 12, at Newcastle, a presentation was made to Mr. George Jude, head foreman of the Forge Department at Elswick Works, of Sir W. G. Armstrong, Whitworth & Company, Limited, on the occasion of his 82nd birthday, and in appreciation of 58 years' continuous service at the Elswick Works.

MR. J. HALLIDAY, of Manchester, has retired from the board of Samuel Fox & Company, Limited, steel and iron manufacturers, of Sheffield, owing to advanced age, and is succeeded by Mr. Samuel Doncaster, of the firm of Daniel Doncaster & Sons, Sheffield. Mr. Halliday joined the board when the company was formed in 1871.

COLONEL CUTLER has decided to retire from the board of Wm. Jessop & Sons, Limited, after serving the company for many years. Mr. J. H. Fisher, who has been connected with the company for a considerable time in the capacity of works manager, has been elected to fill the vacancy caused by the resignation of Colonel Cutler.

THE officials of Vickers, Sons & Maxim, Limited, entertained Mr. J. Dunn, late director of the company, at dinner on March 11. Mr. Dunn, who was Assistant Director of Construction to the Admiralty before he joined Messrs. Vickers, has recently retired from the board of directors, and is now in the position of consulting naval adviser to the company.

MESSRS. DICK, KERR & COMPANY, LIMITED, and A. Schonfield & Company, had petitions before Mr. Justice Neville, in the Company's Winding-up Court, on March 1, for the compulsory winding up of the British Aluminium Company, Limited. The petition was allowed to stand to the first petition day in May, the company to continue the undertaking.

MR. PERCY LONGMUIR, B.Met., consulting metallurgist, of Sheffield, has recently joined the permanent staff of S. Fox & Company, Limited, in the capacity of chief metallurgist and superintendent of research laboratories. The intention is to take full advantage of the aids offered by the higher branches of applied science, and to this end extensive chemical, physical, and metallographical laboratories are being installed.

MR. BARKER, secretary and managing director of Brown, Bayley's Steel Works, Limited, who has been associated with the company since its formation, has decided, owing to increasing years, to relinquish some of the daily duties associated with the management and control of a large concern, but he will continue to be a director and attend the meetings of the board. The directors have appointed Mr. M. Mainprice to succeed him in the position of secretary.

THERE was an interesting celebration at West Bromwich, on Saturday, February 12, of the golden wedding of Mr. and Mrs. Josiah Guest, of Halton House, Beeches Road, West Bromwich. Mr. Guest is one of the best known of British ironfounders, and is very widely respected in the trade. His grandfather and the late Sir Josiah Guest were brothers, and that branch of the family is associated with the firm of Guest, Keen Nettlefolds. Mr. Guest's father is credited with having cast the first chilled roll, and is known to have greatly improved the method of roll making, an industry which, for many years, has had its most important centre at West Bromwich. Mr. Guest, senior, came from Wales to West Bromwich in 1820, and his son, Mr. Josiah Guest, was born in 1837. For a time he was employed at Messrs. Johnson's iron and steel works, and subsequently worked with his brother at the Victoria Iron Foundry, Great Bridge, the firm then being Guest & Bridge. Somewhat later Mr. Guest acquired the business of which he is now the head, trading with his two sons as Josiah Guest & Sons, at the Victoria and Albert Works, as roll makers and general iron founders. He has for many years been a borough magistrate, and for a long time had a seat on the Town Council, the Board of Guardians, and the School Board. In recent years, however, the pressure of business has compelled him to relinquish these positions. Like himself, Mrs. Guest may be said to be of iron trade descent. Her father was the late Mr. Edward Holden, for many years connected with the well-known Bloomfield ironworks of Messrs. Barrows, at Tipton. Subsequently, Mr. Holden joined the late Mr. John Lee when they traded together at the Wellington Iron Works, Swan Village, and the Excelsior Iron and Steel Works. The couple received numerous congratulations, and many handsome presents, among the latter being a fine drawing-room clock from the workpeople of the Victoria and Albert Iron Foundry.

AT the Keighley Institute, on March 12, Mr. Percy Longmuir, B.Met. (Sheffield), Carnegie medallist, gave a lecture before the local Association of Engineers on "Cast Iron." Mr. C. H. Caton presided.

THE Chief Inspector of Factories has issued a memorandum by His Majesty's Electrical Inspector of Factories dealing with the regulations made by the Secretary of State in December, 1908, for the generation, transformation, distribution, and use of electrical energy in premises under the Factory Acts. The memorandum is intended to assist occupiers and others in complying with the regulations by explaining in detail what precautions are required in the case of various types of installations, and in what circumstances exemption may be claimed.

SOUND

STRONG, CLOSE-GRAINED

CASTINGS

Obtained by using

"TITANIUM THERMIT"

TINS READY FOR USE. **ALL SIZES from 2 cwt. to 20 tons.**

Prices and Particulars from

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ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Navigation Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

Metals.	End Mar., 1910.	End Mar., 1909.
Iron—Scotch pig warrants ton	*57/7½	*52/4½
—Middlesbro' warrants ... ton	51 7½	46 4½
—W.C. M/nos Bessemer ... ton	70 0	57 0
—Stock, Scotch ... ... tons	1,000	1,000
Copper—Chili bars, G M B ton	£57 12 6	£56 7/6
—Stock, Europe and afloat tons	—	52,355
Tin—English ingots ... ton	£149 10,0	£132 10/0
—Straits ... ... ton	£151 10,0	£130 17/6
—Stock, London, Holland, U.S.A., and afloat ...tons	—	20,912
Lead—English pig ... ton	£13 10/0	£14 0/0
Spelter—Ord. Silesian ... ton	£23 0 0	£21 8 9
Quicksilver (75lb)... bottle	£9 5 0	£8 7.6
Antimony—Regulus ... ton	£30 10,0	£30 0/0—£31 10/0

* Settlement price.

Castings.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	6 15 0
Pipes, 1½ to 2½ in.	4 17 6	to	5 2 6
,, 3 to 4 in.	4 10 0	to	5 0 0
,, 5 to 8 in.	4 7 6	to	4 10 0
,, 10 to 16 in.	4 7 6	to	4 10 0
,, 18 to 24 in.	4 7 6	to	4 10 0
Chairs	3 10 0	to	3 12 6
Floor plates (open sand)	3 2 6	to	3 5 0

Scrap.

The quotations for scrap, subject to market fluctuations, are as follows:—Heavy wrought (mixed), £2 9s. 0d.; light wrought, £1 7s. 6d.; heavy cast, £2 10s. 0d.; all per ton f.o.b., London. Copper (clean), £56 0s. 0d.; brass (clean), £37 0s. 0d.; lead (usual draft), £12 10s. 0d.; tea lead, £11 10s. 0d.; zinc, £17 0s. 0d.; all per ton delivered merchant's yard.

New Companies.

Quality Saw Company, Limited.—Capital £1,000 in £1 shares, to carry on the business of tool manufacturers, etc.

Britannia Engineering Company (1910), Limited.—Capital £32,000 (2,400 £5 preference and 20,000 £1 ordinary), to adopt an agreement with V. R. Nicholson.

Finsbury Engineering Works, Limited.—Capital £500 in £1 shares, to carry on the business of engineers, founders, etc. Registered office: 1-4, Finsbury Parade, Wood Green, N.

British Humboldt Engineering Company, Limited.—Capital £5,000 in £1 shares, to carry on the business of engineers, founders, etc. Registered Office: Dixon House, Lloyd's Avenue, E.C.

Thos. Adshead & Sons, Limited.—Capital £15,000 in £1 shares, to carry on the business of brass and iron founders, wrought-iron workers, etc., and to adopt an agreement with T. W. Adshead.

Turley & Williams, Limited.—Capital £5,000 in £1 shares, to take over the business of general coppersmiths, braziers, and sheet and other metal workers, carried on by Turley & Williams, at 51-53, Coventry Street, Birmingham.

Increased Power Company, Limited.—Capital £1,000 in £1 shares (500 preference) to carry on the business of manufacturers of leather, canvas, and rubber driving belts and compositions for preserving the same, etc. Registered office: 3, Budge Row, E.C.

Brooks, John (Lye), Limited.—Capital £15,000 in £1 shares, to take over the business of anvil, hammer, and vise manufacturers, carried on by S. A. Brooks, T. Brooks, and S. J. Brooks, at Locks Works, Brook Street, Wollescote, near Stourbridge, Worcs., as John Brooks.

Leonard Chapman & Company, Limited.—Capital £2,500 in £1 shares, to take over the business of manufacturers of and dealers in graphite, plumbago, crucibles, etc., carried on at Munton Road, S.E., as Leonard Chapman & Company. Registered office: Munton Road, New Kent Road, S.E.

Bassett-Lowke, Limited.—Capital £20,000 in £1 shares, to take over the business of manufacturers of and dealers in engineering models, carried on by W. J. Bassett-Lowke and H. F. R. Franklin, at Northampton, and at 112a, High Holborn, W.C., as W. J. Bassett-Lowke & Company.

Hope Works, Limited.—Capital £3,000 in £1 shares, to carry on the business of founders, metal casters, etc., to acquire the business carried on by the receiver for debenture holders at Hope Works, Selborne Street, Walsall, as J. W. James & Company, Limited, and to adopt an agreement with H. Crowther.

Lund & Sergent, Limited.—Capital £2,000 in £1 shares, to carry on the business of ironfounders, automobile and general engineers, etc., to acquire the business carried on at Wellington Road, North, Stockport, Cheshire, as Lund & Sergent. Registered office: Wellington Road, North, Stockport, Cheshire.

Yorkshire Boiler Company, Limited.—Capital £5,000 in £1 shares (500 preferred, 1,000 ordinary, and 3,500 deferred), to take over the business of a mechanical, heating, ventilating, and general engineer, carried on by W. Casmey, together with patents granted for inventions relating to improvements in boilers, etc.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
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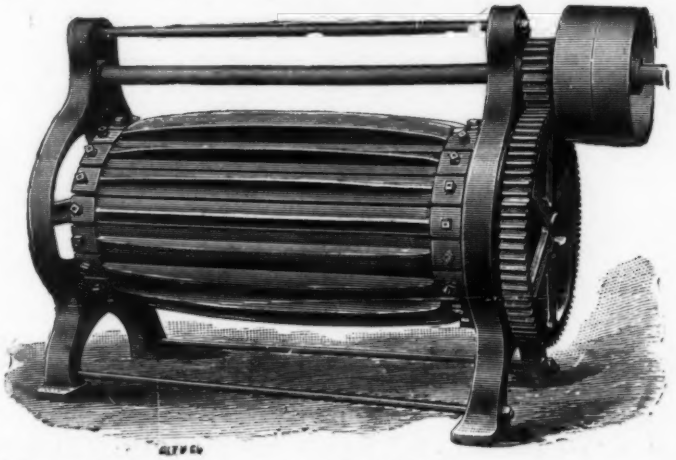
Manufacturers of all

FOUNDRY EQUIPMENTS,

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST.

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

IMPROVED FOUNDRY RATTLER or FETTLING DRUM.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD."

REDUCE YOUR CLEANING ROOM COSTS

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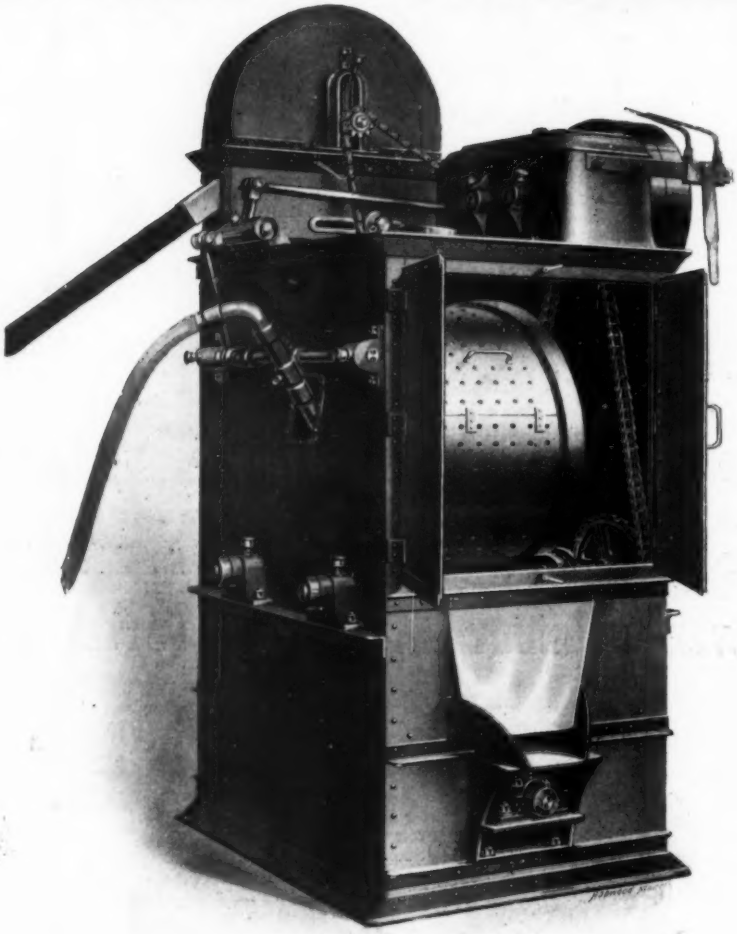
SAND-BLAST MACHINERY.

Give Castings better appearance.



Castings Machine quicker, Saves the machine tools.

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LARGE OUTPUT AT LOW COST.

MOULDING MACHINES, SAND PREPARING MACHINES.

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DEPARTMENT C1.

THE BUYER'S GUIDE

Addresses and further information will be found by reference to the Firm's Advertisement.

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Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Electrically Driven).
Jackman, J. W., & Co., Ltd.
Marshall & Co. Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Steam).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Belt).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Annealing.
Phillips, J. W. & C. J.

Ash Crushing and Washing Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

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Phillips, J. W. & C. J.
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Olsen, Wm.

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Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
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Buffalo Forge Co., Ltd.
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Marshall, H. P., & Co., Ltd.
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Samuelson & Co., Ltd.
Sonnenthal, Selig, & Co.
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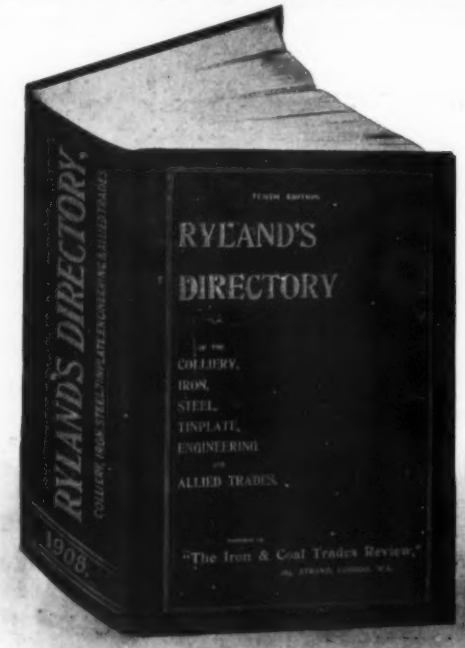

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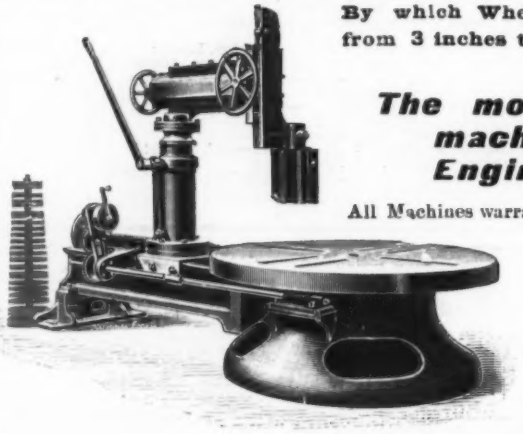

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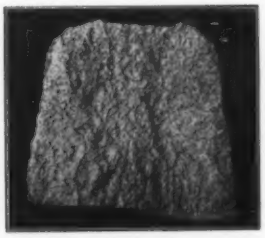

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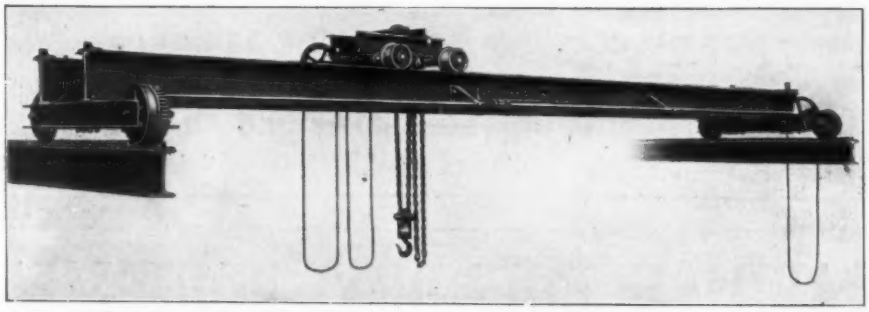

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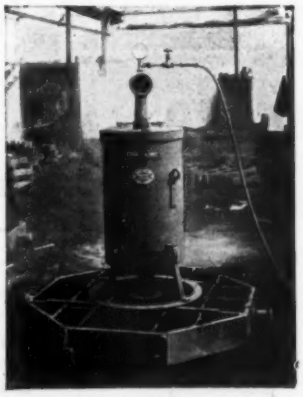

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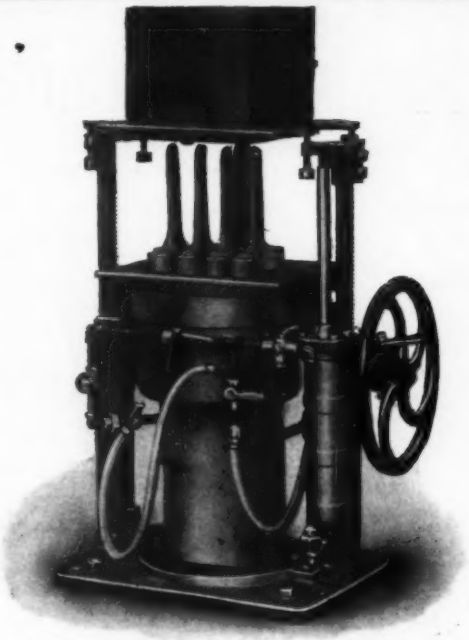

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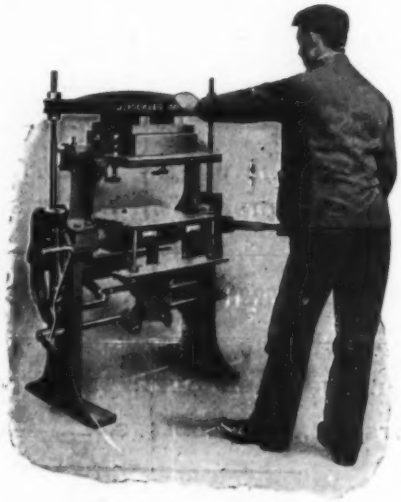

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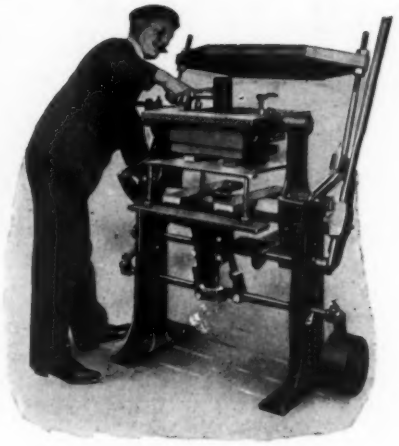

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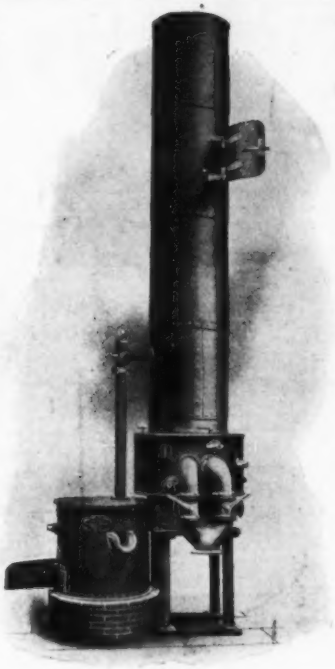

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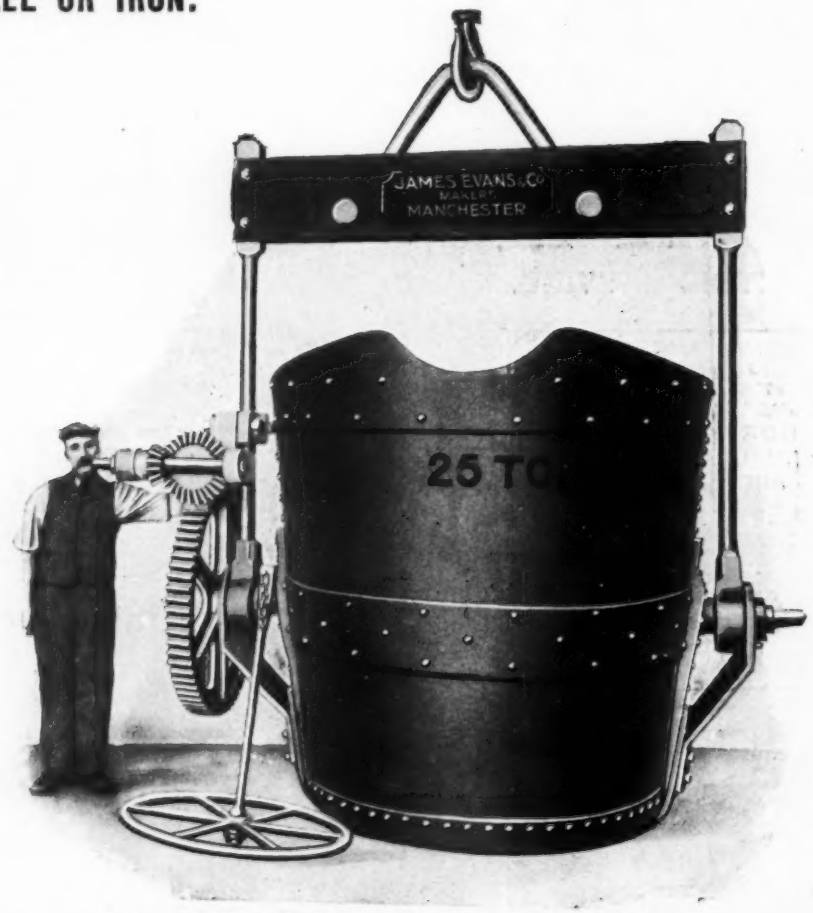

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